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Besides the author's separates, and in addition to the regular edition of the Bulletin, 100 copies were issued in signatures as printed, each signature bearing at the bottom of the first page the date of publication.

Article I.—A PRELIMINARY STUDY OF THE GRACKLES OF THE SUBGENUS QUISCALUS.

By FRANK M. CHAPMAN.

The seventeen members of the genus *Quiscalus* fall into three natural groups, or subgenera, which are known as *Holoquiscalus*, *Megaquiscalus*, and *Quiscalus*. *Holoquiscalus* contains nine species, which range through the West Indies to Trinidad, Cayenne, and Venezuela; *Megaquiscalus* contains five species, which range from Virginia southward along our eastern coasts, through Mexico and Central America to Bogota in Colombia, two of which enter our limits,—*Quiscalus major*, as just stated, reaching Virginia, while its southern limit is marked by the northern boundary of the range of *Quiscalus macrourus*, or about the mouth of the Colorado River in Texas. The subgenus *Quiscalus* contains three forms, which are wholly North American and bear no close relationships to the other members of the genus. *Quiscalus æneus* breeds from the Rio Grande Valley to northern British America and from the eastern slope of the Rockies to the western slope of the Alleghanies, while from Massachusetts to Nova Scotia it reaches the Atlantic seaboard; *Quiscalus quiscula aglaeus* is typically represented from New Orleans to Charleston and southward to the extreme point of the Florida peninsula; and *Quiscalus quiscula* breeds from the northern limit of the range of *aglaeus* northward to the southern limit of the range of *æneus* in the lower Connecticut and Hudson River Valleys. Its northern limit, therefore, coincides with the boundaries of the Carolinian fauna.

These three birds form a group so widely separated from its nearest allies that its origin is not now determinable. A part of their range corresponds with that of *Quiscalus macrourus* and *Q. major*, and it is probable that, like these birds, they have been derived from neotropical ancestors.

Quiscalus æneus was described as a species by Mr. Ridgway in 1869, since which time it has been variously ranked as a species or subspecies by different writers, who either believed in or were

unconvinced of its intergradation with *quiscula*. A question has also arisen, among those who regarded the two birds as only sub-specifically separable, concerning the manner in which their intergradation is accomplished. Is one bird an imperfectly differentiated offshoot of the other, and are the connecting intergrades geographical intermediates, or have we here two distinct species whose intergradation is due to interbreeding where the confines of their respective habitats adjoin? In other words, the question is one of geographical variation versus hybridization, and the object of this paper is to present the facts of the case so far as they are determinable by the material available for study.

The generous and active coöperation which the specialist receives in bringing together large series of specimens for detailed comparison is an important and characteristic feature of ornithological research in America. The uniform courtesy with which a request for the loan of material is granted enables the student to form at once much larger collections than through his own unaided efforts he could gather in years. Thus, through the assistance of fellow-workers, I have examined over 800 specimens of our Grackles, but, I regret to say, even this large number has proved insufficient to complete the chain of facts, without which we cannot hope to draw satisfactory and final conclusions concerning the exact relationships of the birds under consideration. The concluding table gives the number of specimens I have examined and from whom they were received. To each of the gentlemen mentioned therein I desire to express my very hearty thanks for the aid they have so freely given me. To Mr. Brewster, Mr. Ridgway, Dr. Warren, Dr. Avery, Mr. Austin F. Park, and Mr. J. T. Park, I am particularly indebted for especial efforts in my behalf.

Before proceeding to a discussion of the relationships of the three birds it will be necessary to give some attention to their coloration and diagnostic characters. It may here be mentioned that all the comparisons have been based entirely on breeding males; that is, on birds taken later than April 15, a date when nesting has begun and the migration is practically over.

Quiscalus æneus.

ADULT MALE IN THE BREEDING SEASON.—The following description of a typical male is based on the examination of eighteen breeding specimens, from Erie, Penn., Wheatland, Ind., and Mt. Carmel, Ill. Head and neck purplish steel blue, more purplish anteriorly; back, rump, and underparts rich, metallic olivaceous bronze, or brassy bronze; upper and under tail-coverts purplish brassy; tail reddish purple, the exposed portions of the feathers with brassy reflections; primaries blackish, secondaries and wing-coverts of the same color as the tail, but the colors are richer and more intense, the coverts broadly tipped and edged with brassy.

Variations.—*Head and Neck*: The variations of the head and neck are the same as those which occur in *quiscula*; that is, there are three types of coloration with their various degrees of intergradation. Briefly, these are (1) the purple type, with more or less bronzy reflections, this closely resembling the color of the same parts in *aglaus*; (2) the steel-green or bluish-green, and (3) the steel-blue or purplish-blue, previously described, which occurs in about twenty-five per cent. of the specimens examined.

Back and Underparts.—The colors of the neck and body are very clearly defined; there is, however, an occasional slight overlapping of the steel blue on the bronze, the result being a few purple-tipped bronze feathers at the line of juncture of the two colors; the back and underparts themselves vary only in intensity and brilliancy of coloration; earlier in the season they are brighter and more brassy, later darker and more deeply olivaceous bronze.

Wings and Tail.—The wings and tail present no variations other than those incident to wear and exposure of plumage.

ADULT FEMALE IN THE BREEDING SEASON—The following description of a typical female is based on the examination of thirteen breeding specimens from Erie, Penn., Kankakee marshes, Ind., and Mt. Carmel, Ill. The differences existing between male and female specimens of *æneus* consist simply in brilliancy of coloration. The pattern of coloration is exactly the same; the purple, blue, or steel blue of the head and neck are as sharply defined in the female as in the male; the back always shows at least a trace of bronze, and the brightest specimens cannot be distinguished from dull-colored or worn males.

Quiscalus quiscula.

ADULT MALE IN THE BREEDING SEASON.—The following description of males is based on the examination of fifty-one breeding specimens from West Chester, Penn. The range of variation in *quiscula*, as represented by this series from one locality, is so great that it is not possible to select a specimen which shall serve as a type for the description of the species. There are three distinct phases of coloration, which may be termed (1) the bottle-green, (2) the bronze-purple, and (3) the brassy bluish-green. Between these phases there is

every degree of intergradation, and the result is a confusion of characters which require detailed description.

Two specimens of this series agree with phase No. 1, or the bottle-green phase; they have the head and neck steel blue; but so far as coloration goes, in other respects, closely agree with true *aglaus*.

Fifteen specimens are typical of phase No. 2, or the purple-bronze phase. In this phase the head is either purple, steel blue, or steel green; the feathers of the back and underparts are widely margined with bronzy purple, there is a subterminal iridescent band, and a concealed base, varying from brassy bronze to bronzy purple. The rump varies from bronze, or brassy bronze, to bronzy purple, in two specimens the feathers are tipped with iridescent spots; the upper tail-coverts are bronzy purple; the wings and tail agree in coloration with phase No. 1, but are heavily glossed and margined with bronzy purple. Eleven specimens are intermediate between phases No. 1 and No. 2, the intergradation being effected by a decrease in the width of the bronze-purple terminal bar characteristic of the feathers of the back in phase No. 2, followed by a proportionate increase in the width of the bottle-green bar of phase No. 1. Held in certain lights these intermediate specimens may appear typical of either phase as one receives the green or bronze-purple reflections from them. In phase No. 3 (nine specimens) the brassy bluish-green phase, the head and neck agree in coloration with phase No. 2; the change in the color of the feathers of the back is effected by the substitution of a brassy bluish-green terminal bar for a bronze-purple one, by the less clear definition of the iridescent subterminal band, by an increase in the width and constancy of the basal brassy bronze, which in two specimens is not concealed, the terminal brassy bluish-green being then proportionately reduced. In four specimens the rump and lower back are brassy bronze or olivaceous bronze; in the remaining four it is brassy bronze with purplish reflections; in one of the last four the feathers of the rump have terminal iridescent spots; the upper tail-coverts, wings and tail agree with those of phase No. 2. Thirteen specimens are intermediate between phases No. 2 and No. 3, these intergrades being produced by a mingling of the bronze-purple and brassy bluish-green colors of the back. Phases No. 1 and No. 3 do not intergrade directly, No. 2 being a transitional phase between them.

ADULT FEMALE IN THE BREEDING SEASON.—The following description of the female is based on the examination of sixteen breeding specimens from West Chester, Penn. The female in *quiscula* presents fully as much variation in color as the male, the less conspicuous coloring, however, renders it difficult to properly determine the color-phases corresponding to phases of the males. The head is variously purple, steel blue or steel green; seven specimens have the feathers of the back basally purple, bronze purple, or brassy bronze, with subterminal iridescent bars and terminal bands of bronze purple or brassy bluish-green; five specimens are dull, lustreless bronze with slight purplish reflections; four specimens are intermediate between these two phases. The variations of the rump, wings, and tail correlate with those of the back.

Quiscalus quiscula aglæus.

ADULT MALE.—So far as coloration goes *Quiscalus quiscula aglæus* represents the extreme development of phase No. 1 of *Quiscalus quiscula*. The differences in color which exist between Washington and Chester County, Penn., specimens of this phase and examples from South Florida consist in the greater average intensity of the green of the back, the southern birds being, as a rule, slightly darker, and in the color of the head. In Florida birds this part varies from a steel blue to bronzy purple, the last being the prevailing color, while in the northern bird steel blue is the prevailing shade. Many Florida birds, however, can be exactly matched in color by northern specimens. Further variation in my series of sixty males from Southern Florida is shown in the direction of phase No. 2 of *quiscula*, of which there are two specimens, while twelve others are intermediate between phases 1 and 2; No. 1, therefore, being represented by forty-six specimens, or seventy-six per cent., while in Chester County only four per cent. of the specimens can be referred to this phase.

ADULT FEMALE.—The females of *aglæus* do not present so wide a range of variation as do the females of *quiscula*. The most highly-colored specimens, however, are brighter than the extremes in *quiscula*. Such specimens have the feathers of the back rich purple basally, while the tips are occupied by an iridescent band.

In size *aglæus* averages smaller than either *æneus* or *quiscula*, but has the bill actually as well as proportionately longer. The succeeding table of measurements shows in detail the differences in size which exist between the three forms.

Lack of a large series of breeding specimens has, in the present case, forced me to use winter birds. With little doubt, however, they represent the resident bird, and in any event all of the phases mentioned are shown by summer males.

YOUNG BIRDS.—Young birds of the three forms in first, or nestling, plumage are indistinguishable from one another, but when the first plumage is fully grown slight purplish or bronzy reflections may, in *quiscula* and *æneus*, give some indication of parentage. Of *aglæus* my only young specimen is in incomplete first plumage. Soon after the acquisition of the first plumage a complete molt, including wing and tail-feathers, occurs, and the bird passes at once into the full adult plumage with a head which may be purple, steel blue or steel green, showing that the variation in the color of the head is not due to age.

I have found no evidence of a molt in the spring.

MEASUREMENTS.—The differences in size, which exist between these three forms, are too slight to be of diagnostic value in individual cases, the range of variation in either form completely overlapping the average differences. Still a study of average measurements, based on series of specimens taken throughout the range of each form, develops some points of interest.

Quiscalus æneus presents a slight but regular increase in size northward, the accompanying table showing in detail the differences in dimension of specimens taken throughout its habitat. On the whole it appears to be a somewhat smaller bird than *quiscula*, with perhaps a slightly longer tarsus. A comparison of the average measurements of District of Columbia specimens with those of Mt. Carmel, Ill., and Wheatland, Ind., examples, and of the West Chester, Penn., series with the series from Erie, may be considered to show the differences in size which exist between the two species.

In *agileus* and *quiscula*, in passing from the South northward, we find about the same increase in size shown by *æneus*; the wing and tail become longer, the bill thicker, but the length of this member decreases; Florida specimens (*agileus*) having an actually, as well as relatively, longer bill than northern specimens. A series of twenty-five birds from Shelter Island, N. Y., present an exception to the rule of increase in size northward, and average smaller than the Washington specimens. Most of the Long Island birds, however, were taken in June, and their apparently smaller size may be due to worn plumage.

AVERAGE MEASUREMENTS OF BREEDING MALES OF *Quiscalus quiscula* AND
Quiscalus quiscula agileus.

LOCALITY.	No of Specimens.	Wing.	Tail.	Tarsus.	Expos'd Culmen	Depth of Bill at Nostril.
Indian River, Fla.....	24	5.88	4.90	1.45	1.25	.42
District of Columbia.....	11	5.62	5.14	1.44	1.20	.47
West Chester, Penn.....	50	5.66	5.18	1.47	1.18	.46
Shelter Island, N. Y.....	25	5.56	4.94	1.46	1.17	.45

AVERAGE MEASUREMENTS OF BREEDING MALES OF *Quiscalus æneus*.

LOCALITY.	No of Specimens.	Wing.	Tail.	Tarsus.	Expos'd Culmen	Depth of Bill at Nostril.
San Antonio, Tex.....	2	5.34	4.70	....	1.23	.49
Cook County, Tex ...	2	5.47	4.83	....	1.19	.47
Warner, Tenn.....	6	5.50	5.11	....	1.18	.44
Bell, Ky.	2	5.54	5.28	1.48	1.20	.46
Mt. Carmel, Ill ...	3	5.56	5.16	1.49	1.16	.44
Wheatland, Ind....	3	5.51	5.31	1.48	1.12	.45
Erie, Penn.....	8	5.60	5.09	1.53	1.15	.44
Fort Snelling, Minn ...	3	5.59	4.91	1.53	1.17	.46
Pembina and Ft. Rice, N. Dak...	3	5.65	5.24	....	1.17	.44
Vicinity of Cambridge, Mass ...	21	5.62	5.04	1.46	1.21	.47
Vermont, Maine & New Brunswick.	9	5.71	5.36	1.45	1.19	.46

SUMMARY.—In order that the discussion of the inter-relationships of the three forms just described may be easily followed, it is important that their plumages should be thoroughly understood. Omitting all reference to the color of the head as too variable a character to be used in diagnosis, we may know *æneus* as a bird in which the back and underparts are metallic brassy, or olivaceous bronze without iridescent bars in any part of the plumage. *Quiscula* assumes three phases of coloration which merge into one another in the order named: first, the bottle-green; second, the bronze-purple; and third, the brassy bluish-green. In each of these phases the feathers of the back and underparts are banded with iridescent bars of varying extent. *Quiscalus quiscula aglaus* represents the highest development of phase No. 1 of *quiscula*. Keeping these points of difference before us, we may follow the variations presented by each form throughout its range.

BREEDING RANGE OF *Quiscalus æneus*.—I shall here consider *æneus* only as my material typically represents it, its relationships and intergradation may be treated of through *aglaus* and *quiscula*. The description given of a typical series of *æneus* covers all the variations presented by a series taken throughout its range, and it will not be necessary to discuss these specimens in detail. Briefly it may be said that for a bird having so wide a breeding range *æneus* presents remarkably slight variations, either in color or size.

The localities represented by breeding specimens (see the accompanying map) are the following :

Texas, San Antonio, (Attwater), Cook County (Ragsdale). **Louisiana**, Clinton (Kohn). **Alabama**, Greensboro' (Avery). **Tennessee**, Warner, Hickman County (Park). **Kentucky**, Bell, Christian County (Bacon). **Illinois**, Mt. Carmel (Ridgway). **Indiana**, Wheatland (Ridgway). **Pennsylvania**, Erie (Sennett), Meadville (Sennett). **Michigan**, Oden (Brewster), Petoskey (Dwight). **Minnesota**, Fort Snelling (Mearns). **Dakota**, Fort Rice (Allen), Pembina (Coues). **Wyoming**, Laramie Peak (Hitz). **Colorado**, Denver (Henshaw), Fountain (Aiken). **Montana**, Fort Custer (Bendire). **British America**, Fort Resolution (Kennicott), Great Slave Lake, Big Island (Reid). **Ontario**, Hamilton (McIlwraith). **New York**, Leyden, Lewis County (Fisher), Locust Grove (Fisher), St. Regis Lake (Roosevelt). (**Hudson Valley, Massachusetts** and **Connecticut** will be considered under *quiscula*.) **Vermont**, Middlebury (Knowlton). **Maine**, Calais (Boardman), Oxford County (Brewster), Ft. Fairfield (Dwight). **New Brunswick**, Woodstock (Adney), Hillsborough (Dwight).

Mr. William Palmer¹ observed Grackles, which undoubtedly were *æneus*, at St. John's, N. F. A line connecting the two most northern points from which the species has been recorded, therefore, corresponds closely with the northern limit of trees.

Distribution during the Migratory Season and in the Winter.—During both the spring and fall migrations *æneus* occurs east of the Alleghanies, but the centre of abundance in the winter seems to be the lower Mississippi Valley ; and the bird is apparently unknown from the South Atlantic seaboard. In the Atlantic States, Aiken, South Carolina, is the most southeastern locality represented ; there are no specimens from Georgia, and the species has never been recorded from Florida. There are numerous specimens from Alabama, Louisiana, and Texas—the most southern locality represented in the last-named State being Banquette, near Corpus Christi. There is no record from Mexico, but at Eagle Pass Mr. Negley² reports the species as arriving in the spring from the South, and there can be no doubt, therefore, that some birds winter south of the Rio Grande.

The eastward extension of *æneus* through New York and Massachusetts to the Atlantic coast, and thence northward to

¹ Proc. U. S. Nat. Mus., XIII, 1890, p. 263.

² Cooke, Bird Migration in the Miss. Valley, 1888, p. 175.

New Brunswick, renders its habitat unique among North American birds. This singular eastern distribution, however, is in a measure paralleled by that of *Lanius ludovicianus*, and has probably occurred in the same manner.¹ The Loggerhead Shrike has apparently reached northern New England by passing from the Mississippi Valley eastward along the Great Lakes, and is thus regularly found breeding in central New York and northern New England, but is known only as a migrant in the lower Hudson and Connecticut River Valleys.

BREEDING RANGE AND RELATIONSHIPS OF *Quiscalus quiscula agleus* AND *Quiscalus quiscula*.—We will here ignore the distinction created by the name *agleus* and consider *quiscula* as a species ranging from the southern extremity of Florida northward to the Connecticut River Valley. We have already seen that in southern Florida phase No. 1 of *quiscula*, or the bird known as *agleus*, reaches its highest development, while phase No. 2 is barely represented, and No. 3 is entirely wanting. We may now trace the distribution and relationships of these phases with one another and with *æneus* by considering in geographical order the entire series of specimens at our disposal. It will soon be evident that without a large number of examples the exact status of the birds of any one locality cannot be accurately determined.

Northern Florida.—Three specimens from Gainesville (Bell and Chapman) are referable to phase No. 1, one is intermediate, and two agree with phase No. 3. Two specimens from Rosewood (Maynard), two from the lower Suwanee River (Chapman), and one from Talahassee (Brewster), represent phase No. 1, while a second specimen from the last-mentioned locality is intermediate between phases Nos. 1 and 2.

**Georgia.*—A single specimen from St. Mary's (Brewster) is typical of phase No. 1.

Alabama.—Sixteen specimens, collected by Dr. Avery at Greensboro', are, in some respects, different from any I have examined. For the present, however, they may be classified as

¹Cf. Merriam, Bull. N. O. C., III, 1878, p. 55.

follows: Phase No. 1, two; intermediates, six; phase No. 2, seven, while the sixteenth specimen, taken July 17, 1889, is typical *æneus*. Unfortunately the late date at which this bird was secured renders its breeding at Greensboro' open to question, and it is not improbable it may be a wanderer from a more northern locality.

A male from Anniston (Avery) is intermediate between phases Nos. 1 and 2.

A male from Coosada (Brown) is referable to phase No. 1.

Louisiana.—Of seventeen males from New Orleans, Madisonville, and Mandeville (Kohn, Fisher and Galbraith), eight are referable to phase No. 1, seven are intermediates, while the remaining two are typical of phase No. 2. From Clinton, about fifty miles northwest of New Orleans, there is a specimen of *æneus* taken by Mr. Kohn, June 6, 1888. The specimen has the anterior interscapulars lightly tipped with bluish green, but the difference from typical *æneus* is so slight that it is difficult to say whether this variation is purely individual or not.

Dr. F. W. Langdon records "*Quiscalus quiscula*" as probably breeding in West Baton Rouge Parish.¹ I have not seen the specimens on which this record is based, and cannot say, therefore, which phases of *quiscula* they represent.

Mr. C. W. Beckham has recorded *æneus* as occurring in April at Bayou Sara,² but does not state that he found it breeding.

Tennessee.—Eleven specimens taken from "one colony" at Warner, Hickman County, by J. F. Park, are all typical *æneus*. Dr. Fox writes me concerning his record of the occurrence of *æneus* and *quiscula* at Rockwood, Roane County, that "the birds were not breeding at the time they were shot." He further says that "the first flock was seen March 16, and none were met with again until the 26th, after which a flock could be found on or near a certain large tree every day of my stay." The specimens collected by Dr. Fox are now in the United States National Museum, and have been loaned me by Mr. Ridgway. The March specimens we may ignore as probable migrants, but it

¹ Journ. Cincinnati Soc. Nat. Hist., IV, 1881, p. 150.

² The Auk, IV, 1887, p. 303.

is quite probable that two males, taken April 11 and 16 respectively, represent the resident form. The first is *quiscula* intermediate between phases 1 and 2, the second typical of phase 2.

Kentucky.—The specimens on which Dr. L. O. Pindar based his interesting record of the breeding of *quiscula* and *aneus* in separate colonies in Fulton County¹ are unfortunately not now in existence.

Dr. Pindar writes me : "I have secured and perfectly identified specimens of each variety, and have found the nests and eggs of each; *aneus* far outnumbers *quiscula*, and during the breeding season they keep apart from each other." Fulton County is in western Kentucky, on the Mississippi River, and it is not impossible that this locality may represent a northern extension of a phase of *quiscula* in the Mississippi Valley.

The importance of this record is evident, but its exact bearing on the question at issue cannot be determined until we know what phase of *quiscula* occurs in Fulton County.

Two specimens from Bell, Christian County, southwestern Kentucky (Bacon), are typical *aneus*.

South Carolina.—Nine specimens taken throughout the year, near Charleston (Wayne), are typical of phase No. 1 of *quiscula* (= *agheus*), which, Mr. Wayne writes me, is the only form that breeds in his vicinity.

North Carolina.—A male taken at Raleigh, June 19 (Brimley), agrees with phase No. 3. This, it will be observed, is the first appearance of this phase.

District of Columbia.—In a series of sixteen specimens taken at and near Washington, three (Fisher and Richmond) are referable to phase No. 1, six (Fisher, Jouy and Richmond) are intermediates between this phase and phase No. 2, two (Richmond) agree with phase No. 2, and four (Fisher) are intermediates towards phase No. 3. The last-named phase is not represented, and the sixteenth bird is a typical example of *aneus*, taken April 17, 1886, by Mr. C. W. Richmond. In 'The Auk,'

¹ The Auk, VI, 1889, p. 314.

Vol. V, p. 19, Mr. Richmond has recorded the capture of this bird, and also of another of the same species, taken April 6, 1887. Both were secured "in a grove of cedars occupied by a colony of Purple Grackles."

Maryland.—Of three specimens from Sandy Spring (Fisher) two are intermediate between phases Nos. 1 and 2, and one is typical of phase No. 3.

Pennsylvania.—In the splendid series of fifty-one breeding males collected in Chester County by Dr. B. H. Warren and Mr. G. W. Roberts, we for the first time find all three phases of *quiscula* associated, and can thus study their inter-relationships to better advantage. Of phase No. 1 there are two typical specimens, which are connected with phase No. 2 by eleven specimens, showing every stage of intergradation. Fifteen specimens are typical of phase No. 2, which in turn is connected with phase No. 3 by thirteen intermediates. Of phase No. 3 there are nine specimens, while one specimen is intermediate between this phase and *æneus*.

In going westward and northwestward from Chester County, and thus approaching the range of true *æneus*, we find *quiscula* represented by phase No. 3 or its intermediates. Thus at Carlisle (Baird) one specimen is intermediate between phases Nos. 2 and 3 and one agrees with phase 3. One example from Dauphin County (Warren) is referable to phase No. 3; one from Centre County (Warren) is intermediate between phase No. 3 and *æneus*, while three specimens from Williamsport (Koch and Warren) are respectively referable to intermediates between phases Nos. 2 and 3, phase No. 3, and intermediates between this phase and *æneus*. From Athens I have two specimens which are between phase No. 3 and *æneus*; from Towanda (Dwight) one example of *æneus*, and from Port Jervis (Dwight), on the northeastern boundary of the State, two specimens, one of which is between phase No. 3 and *æneus*, while the other is *æneus*.

New Jersey.—Of eight specimens from Monmouth County (Zerega), Princeton (Scott and Nicholas), and Raritan (Southwick), four agree with phase No. 2, two are intermediate and two agree with phase No. 3. In a series of seven specimens from

Morristown (Thurber) two are referable to phase No. 2, two are intermediate between this phase and phase No. 3, and three agree with phase No. 3. This locality is interesting as being the last one in which phase No. 2 is typically represented.

New York.—In passing up the Hudson River Valley *quiscula* again approaches the habitat of *æneus*, and the intergradation of the two birds is at once rendered evident. Three specimens from New York City (Dwight) are phase No. 3, one from Westchester County (Fisher) is between this phase and *æneus*, one from Sing Sing (Fisher) agrees with phase No. 3, and a second specimen is intermediate towards *æneus*. Two examples from Highland Falls (Mearns) are *æneus*, while of seven specimens from Troy (A. F. Park) one is referable to phase No. 3—its known northern limit in the Hudson River Valley,—four are intermediates towards *æneus* and two are typical *æneus*.

We may conclude our analysis of specimens by following *quiscula* from the east end of Long Island northward up the Connecticut River Valley into Massachusetts.

Long Island.—The collections of Mr. Brewster, Mr. Dutcher and the American Museum furnish a series of forty-one beautifully prepared skins which were collected by Mr. W. W. Worthington at Shelter Island. This series is most instructive and clearly shows phase No. 3 of *quiscula* to be connected with true *æneus* by such finely graduated steps that it would here be impossible to draw a line between them. Phase No. 2 has now disappeared, and we have only four specimens intermediate between it and phase No. 3. Phase No. 3 here reaches the highest stage of its development and is represented by twenty-nine specimens or (with its intergrades towards *æneus*) ninety per cent. of the whole as against twenty per cent. in Chester County, Pennsylvania. Seven specimens are intermediate between phase No. 3 and *æneus*, of which there is one typical specimen taken June 16, 1886.

Connecticut.—The Long Island specimens have prepared us for what the Connecticut series unquestionably proves, that is, the complete intergradation of phase No. 3 of *quiscula* with *æneus*. Of fifteen specimens, collected by Mr. Sage at Portland, five are

TABLE SHOWING THE DISTRIBUTION OF *Quiscalus quiscula* AND ITS SEVERAL PHASES, BASED ON BREEDING MALES.

LOCALITY.	<i>Quiscalus quiscula.</i>						<i>Quiscalus anens.</i>
	Phase No. 1 <i>-aglaus.</i>	Intermediates.	Phase No. 2.	Intermediates.	Phase No. 3.	Intermediates.	
South Florida.	46	12	2				
North Florida.	8	2	2				
St. Mary's, Ga.	1						
Greensboro', Ala.	2	6					1
Anniston, Ala.		1					
Coosada, Ala.	1						
New Orleans, La.	8	7	2				
St. Tammany Parish, La.							
Clinton, La.							1
Warner, Tenn.							5
Rockwood, Tenn.		1	1				
Bell, Ky.							2
Charleston, S. C.	9						
Raleigh, N. C.					1		
District of Columbia.	3	6	2	4			
Sandy Spring, Md.		3			2		
Chester County, Penn.	2	11	15	13	19	1	
Carlisle, Penn.				1	1		
Dauphin County, Penn.					1		
Centre County, Penn.						1	
Williamsport, Penn.				1	1	1	
Athens, Penn.						2	
Towanda, Penn.							1
Port Jervis, N. Y.						1	1
Monmouth County, N. J.			1				
Princeton, N. J.			2	2	1		
Raritan, N. J.			1		1		
Morristown, N. J.			2	2	3		
New York City, N. Y.					3		
Westchester County, N. Y.						1	
Sing Sing, N. Y.					1	1	
Highland Falls, N. Y.							2
Troy, N. Y.					1	4	2
Shelter Island (L. I.), N. Y.				4	29	7	1
Portland, Conn.					5	5	5
East Hartford, Conn.					3	5	2
Woods Holl, Mass.					2	14	10
Taunton, Mass.					1		
Monomoy Island, Mass.						1	
Framingham, Mass.					3	2	
Quincy, Mass.						2	5
Cambridge, Mass.					1		4
Belmont, Mass.							3
Lexington, Mass.							1
Watertown, Mass.							3

referable to phase No. 3, five are intermediates between it and *æneus*, and five are typical *æneus*. Of ten specimens, collected by Mr. W. E. Treat at East Hartford, three agree with phase No. 3, five are intermediates and two are *æneus*.

Massachusetts.—Twenty-six specimens from Woods Holl (Edwards) are for the most part without date, but are evidently spring birds. They further illustrate the gradual replacement of *quiscula* by *æneus*. Only two specimens agree with phase No. 3, fourteen are intermediate between it and *æneus*, while ten specimens are true *æneus*.

Other Massachusetts specimens show that phase No. 3 of *quiscula* is occasionally found even as far north as Cambridge; beyond this, however, *quiscula* in any phase of plumage appears to be unknown, and true *æneus* is found alone. One example from Taunton (Cahoon) agrees with phase No. 3; one from Monomoy Island (Cahoon) is intermediate between this phase and *æneus*; three specimens from Framingham (Eastman) are referable to phase No. 3, while two others from the same place are intermediates towards *æneus*; two specimens from Quincy (Frazar) are intermediate between phase No. 3 and *æneus*, while five additional specimens from the same locality are typical *æneus*; one example from Cambridge agrees with phase No. 3, the known northern limit of this phase, while four other specimens from Cambridge (Brewster), three from Belmont (Brown), one from Lexington (Maynard), and three from Watertown, are all true *æneus*.

CONCLUSIONS.—We may briefly summarize this review of our Grackles as follows: (1) *Quiscalus æneus*, throughout a breeding range which extends from the Rio Grande Valley to British America and New Brunswick, varies in coloration only in that comparatively limited part of its habitat adjoining the area occupied by *Quiscalus quiscula*, with which, at least from Pennsylvania to Massachusetts, it completely intergrades. (2) *Quiscalus quiscula*, an extremely variable form, assumes three phases of coloration, the first reaches its extreme development at the southern limit of the bird's range where the third phase is unknown, while the third phase is most highly developed at the bird's northern limit, where

the first phase is unknown. The second phase connects the first and third, and is rarely found at either extreme, but is most abundant near the centre of the bird's habitat where, it is to be noted, all three phases, with their connectants, occur together. (3) The exact relationships of *quiscula* and *æneus* in the lower Mississippi Valley and northward along the Alleghanies to Pennsylvania are not at present known. (4) In the Alleghanies of Pennsylvania, in the Hudson Valley from Sing Sing to Troy, in eastern Long Island, in Connecticut, and in Massachusetts as far north as Cambridge, *quiscula* and *æneus* completely intergrade. (5) This intergradation is in every instance accomplished through phase No. 3 of *quiscula*.

Here, then, are the apparent facts of the case ; the evidence of to-day is still incomplete, the history of the past may be forever hidden by the veil of time.

It is, of course, inadvisable to theorize from insufficient data, and while I confess no satisfactory solution of the entire problem has presented itself to me, it will not be out of place to try and define its terms as they appear in the light of our present knowledge. First, is *æneus* a species? The aspect of the whole subject depends upon our reply to this question. We have proven beyond doubt that *æneus* and *quiscula* do intergrade; if now we can show their specific distinctness, it follows as a matter of course that their intergradation is due to causes other than those which produce intergradation among subspecies. If *æneus* and *quiscula* are only subspecifically separable, *quiscula* is undoubtedly an offshoot or subspecies of *æneus*. Why then, assuming this to be the case, should this form prove remarkably constant throughout an immense area, and then in a comparatively limited portion of its habitat become abruptly differentiated into three color phases, the extremes of which are as widely separated from each other as *æneus* is from either. Are there any known climatic or geographic conditions which will account for this change? To be more explicit, we find typical *æneus* is the only form which breeds at Warner, Tenn., while at Greensboro', Ala., 200 miles south, *quiscula* is the breeding form. Are there any environmental causes which will differentiate *quiscula* from *æneus* in this intervening area? If so, their action has certainly not been



MAP SHOWING THE DISTRIBUTION AND AREAS OF INTERGRADATION OF *Quercus emu* AND *Q. garfieldi*

shown in the case of more susceptible species. Or, again, in the vicinity of New York *quiscula* is the common form, while in the region about Boston *æneus* is the prevailing bird. Have we among the species which breed at both localities any other instances presenting similar variation? Finally, we have seen that at certain localities *quiscula* and *æneus*, and their intergrades, occur in about equal numbers. Have we among North American birds any instance in which two subspecies are found breeding and intergrading at the same locality?

These are fair test questions, based on known facts in the history of *æneus*. If we can answer them satisfactorily in the affirmative, there is nothing unusual in the case, and *æneus* and *quiscula* simply conform to laws which obtain among undoubted subspecies. If, on the contrary, the case is without parallel, and environmental conditions will not account for the intergradation of these birds, can we do otherwise than admit their specific distinctness and explain their intergradation by hybridization?

For myself, I have no doubt that the latter view is the correct one. Certainly it explains the case in a far more satisfactory manner than do any other influences to which, so far as we know, the birds are subjected. Nor do I see any good reason why we should refuse to admit hybridization as a factor in the evolution of what we term species. There can be no question that, in spite of our test-book assertions to the contrary, we place too high a value on this word 'species.' And while we recognize the 'plasticity' of animal forms and their ready response to the influences of environment, we have been loth to admit that, so far as regular interbreeding was concerned, they are not distinct creations.

Difference in habit under what must necessarily be similar conditions will ever be an effectual barrier against the indiscriminate mixing of even closely-allied birds. But when two species whose natural economy, song, nidification, etc., are the same, and which agree in structural details and differ only in coloration, inhabit contiguous regions, is it unnatural that they should at first occasionally, and in the end regularly, interbreed? The evidence in proof of such intergradation is gradually accumulating, and in the future I think we shall be forced to recognize hybridization

not only as a means which unites known forms, but which also gives rise to new ones.

I would not be understood as advocating an appeal to this cause whenever the facts of a case are apparently not to be explained by recognized evolutionary factors. To call an intermediate a 'hybrid' is an easy way of answering what may be a difficult question. But unless the hybridization has been proven, it is a reply which gives no information whatever, and proves a stumbling-block to more thorough investigation.

It is because of this too frequently unwarranted application of the hybridization theory that most ornithologists have refused to admit its now evident importance. It seems to me, however, that given sufficient data on which to base any theory of the relationships of two intergrading forms, and provided they are not so slightly differentiated that individual variation overlaps the differences which separate them, we should not be in doubt as to whether they are connected through the action of purely environmental causes or by the more direct action of hybridization. The nature of their intermediate characters, the fact that these characters do not correlate with environmental influences, the presence of both species in the area occupied by their intergrades; all should furnish evidence which will enable us to distinguish between hybrids and geographical intermediates.

It is true that such evidence can be derived only from extensive collections and careful field observations, but until both have been made, are we warranted in advancing any explanation of the relationships of connected forms.

NOMENCLATURE.—There result from this study two nomenclatural problems which are not easy of solution. The first relates to *Quiscalus quiscula*. This name conveys no exact meaning, and unless I have examined the specimens, in no instance have the published records of this bird been of service to me.

The only way out of this difficulty, which I see, is to adopt the method we use in writing of dichromatic species and follow the bird's name by its color-phase; or, in labeling, the numerals 1, 2, or 3 may be used to designate their respective phases. I have followed this plan in determining the material used in the present connection, adding the fraction $\frac{1}{2}$ for intermediate specimens.

The second question is, shall we use a binomial or trinomial appellation for birds which intergrade by hybridizing? I would urge the former rather than the latter; first, because trinomials have been applied solely to subspecies, as we understand the term; whereas, in the case of hybridizing forms, the birds are species, and, so far as we can judge, have not been differentiated one from the other, but may be of equal age, or the offshoots of different ancestral stock; further, the intergradation is accomplished by a cause so different from that which gives rise to subspecies that the birds should not be nomenclaturally treated as such. Second, because hybridization, even on the most extended scale, differs from more or less frequent hybridization only in degree, and if we employ trinomials in the first instance there is no reason why we should not use them in every case where a complete connection between two species can be shown by a set of hybrid intermediates. In which case we should, for example, be obliged to say *Helminthophila pinus chrysoptera*!

To conclude, I have termed this paper 'A Preliminary Study,' because the available material has not been sufficient to enable me to present the subject in its entirety. The hybridization of *quiscula* and *æneus*, to my mind at least, is an established fact, but the results of this hybridization, as shown in the color-phases of *quiscula*, cannot be satisfactorily explained until we have numerous specimens from the lower Mississippi Valley northward along the Alleghanies to Pennsylvania. Indeed, specimens from any locality will be of assistance in a further study of the relationships of these birds, and I would earnestly request the loan of breeding male Grackles which I have not already examined. These may be sent to me at the American Museum of Natural History, New York City, whence they will be returned with as little delay as possible.

SOURCES AND NUMBER OF SPECIMENS EXAMINED.

American Museum of Natural History.....	132
J. W. Atkins, Key West, Fla.	6
H. P. Attwater, Rockport, Texas.....	3
W. C. Avery, M. D., Greensboro', Ala.....	19
C. Carrington Bacon, Bell, Ky.....	2
William Brewster, Cambridge, Mass.....	162
Cincinnati Society of Natural History, Cincinnati, Ohio.....	5

Columbia College, New York City.....	40
William Dutcher, " ".....	11
J. Dwight, Jr., " ".....	13
A. K. Fisher, M.D., Washington, D. C.....	38
August Koch, Williamsport, Penn.....	8
Gustav Kohn, New Orleans, La.....	20
T. McIlwraith, Hamilton, Ont.....	2
E. A. Mearns, M.D., Fort Snelling, Minn.....	9
Austin F. Park, Troy, N. Y.....	17
J. T. Park, Warner, Tenn.....	11
Princeton College, Princeton, N. J.....	32
G. H. Ragsdale, Gainesville, Texas.....	2
W. C. Rives, M.D., New York City.....	2
George W. Roberts, West Chester, Penn.....	20
J. Rowley, Jr., New York City.....	3
J. H. Sage, Portland, Conn.....	42
George B. Sennett, New York City.....	22
United States National Museum.....	174
B. H. Warren, M.D., West Chester, Penn.....	49
A. T. Wayne, Charleston, S. C.....	1
<i>Total</i>	845

Article II.—THE NORTH AMERICAN SPECIES OF THE GENUS *COLAPTES*, CONSIDERED WITH SPECIAL REFERENCE TO THE RELATIONSHIPS OF *C. AURATUS* AND *C. CAFER*.

By J. A. ALLEN.

It has been known for more than thirty years that at certain points where the habitats of *Colaptes auratus* and *C. cafer* adjoin birds occur presenting the characters of the two species combined in the most heterogeneous manner, to account for which various hypotheses have been advanced. In order to arrive at the facts of the case, and to reach if possible a solution of the problem, I solicited, some months since, the loan of material for the prosecution of the investigation here detailed. Through the kindness of my fellow-workers, I have been able to bring together 785 specimens of the genus *Colaptes*, representing all of the North American and West Indian forms of the genus. These include nearly all of the available specimens in the leading public and private museums of this country, so far as they were considered especially desirable in the present connection.¹

I am especially under obligations to Mr. Robert Ridgway, Curator of Birds in the U. S. National Museum, for securing for me the use of the specimens under his charge, and to Mr. William Brewster for the loan of one of the most extensive and valuable series of these birds extant. Captain Platte M. Thorne, 22d Inf., U. S. A., sent a series of unusual interest from Colorado and Montana, which he has kindly presented to this Museum. Valuable specimens have also been presented by Mr. L. Belding, of Gridley, Cal., and Mr. R. T. Lawrence, of Olympia, Wash. To various other ornithologists I am under deep obligations for the generous loan of specimens, to each of whom I tender my sincere thanks for their kind coöperation. The subjoined schedule indicates the source and amount of the material on which the present paper is based, arranged alphabetically under the names of con-

¹ The series of *C. auratus* from eastern North America might have been greatly extended had it been deemed necessary.

tributors. The number of specimens received from any single source does not necessarily justly represent the relative value of the contribution, since some of the smaller lots often contain specimens of the highest interest, either on account of the localities represented or from the peculiar character of the specimens themselves.

- Charles F. Batchelder, Cambridge, Mass. 6 specimens.
 Lyman Belding, Gridley, Cal. 5 specimens.
 Capt. Charles E. Bendire, U. S. A., Washington, D. C. 2 specimens.
 William Brewster, Cambridge, Mass. 206 specimens.
 Frank M. Chapman, New York City. 9 specimens.
 Charles B. Cory, Boston, Mass. 3 specimens (*Colaptes gundlachi*).
 Jonathan Dwight, Jr., New York City. 12 specimens.
 B. T. Gault, Glen Ellyn, Ill. 3 specimens.
 E. W. Hasbrouck, Washington, D. C. 5 specimens.
 Gustave Kohn, New Orleans, La. 8 specimens.
 R. T. Lawrence, Olympia, Wash. 5 specimens.
 Prof. John Macoun, Canadian Geological Survey, Ottawa, Can.
 21 specimens.
 Dr. Edgar A. Mearns, U. S. A., Fort Snelling, Minn. 15 specimens.
 George H. Ragsdale, Gainesville, Texas. 2 specimens.
 George B. Sennett, New York City. 22 specimens.
 Ernest E. Thompson, Toronto, Can. 2 specimens.
 Capt. P. M. Thorne, 22d Infantry, U. S. A., Fort Keogh, Mont.
 27 specimens.
 American Museum of Natural History, 178 specimens.
 Princeton College, 38 specimens.
 U. S. Department of Agriculture (through Dr. C. Hart Merriam),
 10 specimens.
 U. S. National Museum (through Robert Ridgway), 208 specimens.

The following statement indicates, in a general way, the geographical sources of the material used.

- | | |
|----------------------------------------|----------------------------------------|
| Alabama, 3 specimens. | Idaho, 1 specimen. |
| Alaska, 8 specimens. | Illinois, 10 specimens. |
| Alberta, Brit. Am., 4 specimens. | Indiana, 7 specimens. |
| Arctic America (British), 9 specimens. | Indian Territory, 4 specimens. |
| Arizona, 82 specimens. | Iowa, 10 specimens. |
| Arkansas, 1 specimen. | Kansas, 6 specimens. |
| Assinaboia, Brit. Am., 3 specimens. | Louisiana, 10 specimens. |
| British Columbia, 58 specimens. | Lower California, 72 specimens. |
| California, 71 specimens. | Maine, 4 specimens. |
| Canada, 5 specimens. | Maryland, 10 specimens. |
| Chihuahua, 23 specimens. | Massachusetts, 16 specimens. |
| Colorado, 45 specimens. | Mexico (southern parts), 10 specimens. |
| Connecticut, 2 specimens. | Michigan, 4 specimens. |
| Cuba, 6 specimens. | Minnesota, 15 specimens. |
| Dakota (both States), 12 specimens. | Mississippi, 2 specimens. |
| Florida, 46 specimens. | Missouri, 1 specimen. |
| Georgia, 1 specimen. | Montana, 44 specimens. |
| Grand Cayman, W. I., 3 specimens. | Nebraska, 7 specimens. |
| Guadalupe Isl., L. Cal., 5 specimens. | Nevada, 10 specimens. |
| Guatemala, 9 specimens. | New Brunswick, 3 specimens. |

New Hampshire, 2 specimens.	Sonora, 6 specimens.
New Mexico, 1 specimen.	Tennessee, 9 specimens.
New Jersey, 18 specimens.	Texas, 24 specimens.
New York, 23 specimens.	Utah, 2 specimens.
North Carolina, 12 specimens.	Virginia, 8 specimens.
Ohio, 1 specimen.	Washington, 13 specimens.
Oregon, 7 specimens.	Wyoming, 8 specimens.
Pennsylvania, 10 specimens.	

In addition to the specimens examined, much information has been gathered from the literature of the subject, and some from unpublished sources, derived from correspondence, particularly in regard to Texas, California and Arizona.

The large amount of material thus brought together has naturally been utilized incidentally for other purposes than that of its bearing on the relationship of *C. auratus* and *C. cafer*, since it afforded exceptionally favorable opportunities for studying the characters of the several forms in their first or nestling plumages, as well as in respect to seasonal, individual and geographical variation. Consequently, a few paragraphs are devoted in the present paper to each of these subjects. Mr. Frank M. Chapman, Assistant Curator in this department, has also further utilized this material as the basis of his paper 'On the Color-Pattern of the Upper Tail-Coverts in *Colaptes auratus*,' recently published in this Bulletin.¹

I.—THE RELATIONSHIPS OF *Colaptes auratus* AND *C. cafer*.

In 1858 Professor Baird, in his Report on North American Birds,² first called attention to the unique and since then notorious case of *C. auratus* and *C. cafer* (or *C. mexicanus*, as then designated), as presented by a large series of specimens from the region of the Upper Missouri and Yellowstone Rivers, in which the characters of the two birds were combined in a constantly varying and often asymmetrical manner. His material enabled him to present very fully the leading facts of the case, and led him to conclude that the state of affairs thus revealed pointed clearly to hybridization on a grand scale between the two species

¹ Vol. III, No. 2, Art. XXI, pp. 311-314, Aug., 1891.

² P. R. R. Expl. and Surv., Vol. IX, pp. 122-124.

in question, notwithstanding the startling nature of such an assumption. While he named the variously intermediate birds *Colaptes hybridus*, he distinctly stated that the name was not given in a specific sense, but merely for the convenient designation of the intermediate birds. Under this name they were currently known in literature for the next quarter of a century. For a time Professor Baird's explanation of the case was very generally accepted as probably correct, but later other hypotheses were suggested. Thus, in 1872, when the distribution of the so-called 'hybrids' was supposed to cover a much smaller area than the examination of the present available material shows to be the case, it was argued that the peculiar intergradation between these two forms might be due to the action of environment,¹ in accordance with certain well-established laws of geographic variation affecting many other species having a somewhat similar distribution. This suggestion met with sufficient favor to render for a time the question at least an open one.²

In 1877 it was suggested that these intermediate birds might be "remnants of a generalized form from which two 'incipient species' have become differentiated," and that "this 'hybrid' series is gradually losing its neutral character through the nearer approach, generation by generation, of its members to the characters of one or the other of the two specialized forms."³ In 1884 it was suggested that the so-called hybrids, or birds of mixed character, may constitute "perhaps.... a hybrid, and perhaps.... a transitional form."⁴

The most recent writer on the subject treats the intermediate birds as a "race," with the nomenclatural status of a species, under the name *Colaptes ayresi*,⁵ which is only an earlier name for Baird's *C. hybridus*. While admitting that this 'race' was "produced originally by the union of *C. auratus* and *C. mexicanus*" (= *cafer*), the suggestion is made that these intermediate birds may be, in some cases, "a sign of reversion to a remote ancestral plumage."⁶

¹ Cf. Allen, Bull. Mus. Comp. Zool., III, No. 6, 1872, pp. 118, 119.

² Cf. Coues, Birds of the Northwest, 1874, p. 293.

³ Ridgway, Orn. 40th Parallel, 1877, p. 556.

⁴ Coues, Key to N. Am. Bds., revised ed., 1884, p. 492.

⁵ A name given by Audubon in 1843 to mixed birds from the Upper Missouri country.

⁶ Hargitt, Cat. Bds. Brit. Mus., XVIII, 1890, p. 8.



MAP SHOWING THE DISTRIBUTION OF THE NORTH AMERICAN *Colaptes auratus*, *C. caper*, AND *C. macrorhynchos* IN THE UNITED STATES AND CANADA.

Before proceeding further, it may be well to consider briefly the distinctive characters and the geographical distribution of each of the several North American forms of the genus *Colaptes*. Beginning at the southward, we have first *C. mexicanoides*, restricted, so far as now known, to Guatemala,¹ but possibly ranging northward to the southern border of Mexico. This is essentially *C. cafer* with the coloration intensified, the black cross-bars of the whole dorsal plumage being broadened, the white rump more or less spotted with black, the entire top of the head and nape rufous instead of cinnamon, and the quills and malar stripe a deeper, darker red. Whether the habitats of *C. mexicanoides* and *C. cafer* actually meet, and whether or not the two forms intergrade, lack of material leaves us in doubt, the region where this should occur, if actually taking place, being unrepresented in the material at hand. The most southern specimens of *C. cafer*, however, tend decidedly toward *C. mexicanoides*, and one example, from Mirador (U. S. Nat. Mus., No. 42,065), may be regarded as a good intermediate, being nearly as much like the one as the other. Allowing the sum of the characters of *C. mexicanoides* to be represented by 100, 80 per cent. of them may be considered as common also to *C. cafer*, as this form is represented in Mexico, with a probability of complete intergradation, since the differences separating them are wholly differences of degree.

The habitat of *C. cafer*, in considering the relation of this form to its northern congeners, is of special interest. *C. cafer* is found from the southern border of Mexico northward throughout Mexico, excepting western Sonora and Lower California, and thence northward over the western part of the United States and British America, from about the eastern base of the Rocky Mountains to the Pacific Coast.

C. rufipileus, from Guadalupe Island, off Lower California, is an insular form of *cafer*, differing from *cafer* mainly in smaller size, much longer bill, and rather deeper colors, in this latter respect rather more resembling *C. cafer saturator* of the Northwest Coast. It was evidently derived from Californian rather than Mexican stock.

¹ See the accompanying map.

C. cafer saturation, from the coast region of Washington and British Columbia, is the inevitable, naturally-to-be-expected Northwest Coast form of *C. cafer*, differing from the latter in slightly larger size and much deeper colors, and passing by insensible gradations into the paler bird of the adjoining interior. Both of these forms are evidently offshoots from the pure *cafer* stock, modified by environment under the ordinary laws of geographic variation prevailing over the regions in question.

C. chrysoides is found in the peninsula of Lower California, where it is the sole representative of the genus; it also ranges into Sonora, and thence northward into southern Arizona and southeastern California. To the northward and eastward its habitat thus reaches, and at some points (at least in winter) overlaps that of *C. cafer*, with which, however, it appears never to blend. At least a large series of Arizona specimens of both species presents no intermediates. While it would be rash to assert that the two forms will not be found to interbreed in Sonora, where for a long distance their ranges must adjoin, and whence as yet material is lacking, I believe that the few intermediates hitherto doubtfully supposed to exist will prove to be *cafer* + *auratus*, wrongly identified as *cafer* + *chrysoides*. In *C. chrysoides* we have, as regards general characters, a small, pale form presenting the general appearance of *mexicanoides*, it being rather nearer this species in the aggregate of its characters than it is to *cafer*; it differs from either, however, in one very radical feature of coloration, namely, in the quills being golden, as in *auratus*, instead of red, as in the *cafer-mexicanoides* group. Yet the golden quills are the only color feature which in any way recalls *auratus*, and hence does not necessarily imply any close genetic relationship between *chrysoides* and *auratus*. Besides, in the large series of *chrysoides* examined there is no trace of any of the distinctive features of *auratus*, such as the red nuchal crescent, the black malar stripes, or the peculiar coloration of the head. If we let the sum of the characters of any form of *Colaptes* be represented by six, five of the characters of *C. chrysoides* would be shared in common with the *cafer-mexicanoides* group and one only by *auratus*.

C. auratus, while ranging over the northern and eastern three-fourths of the continent of North America, has also two outlying

insular forms, *C. chrysocaulosus* of Cuba, and *C. gundlachi* of Grand Cayman, both evidently offshoots from the *auratus* stock, modified by environment, and differing from *auratus* somewhat as *mexicanoides* differs from *cafer*.

The species of *Colaptes* found north of the Isthmus of Panama thus fall into three groups, two of which are much more closely related to each other than either of these two is to the third. These are (1) the *cafer-mexicanoides* group, (2) the *chrysoides* group, (3) the *auratus* group. The first and the last, so far as features of coloration are concerned, are the most unlike, having no special characters in common, and yet it is these two, *cafer* and *auratus*, which, as shown by the material now in hand, thoroughly intergrade wherever their habitats meet, that is, over a belt of country from 300 to 400 miles wide, and some 1200 to 1500 miles long. They are also more or less mixed from the eastern border of the Great Plains westward to the Pacific Coast, from about the latitude of 38° northward to about latitude 55°.

The leading distinctive characters of *C. auratus*, as compared with *C. cafer*, are :

Auratus.

1. Quills *yellow*.
2. Male with a *black* malar stripe.
3. Adult female with *no* malar stripe.
4. A *scarlet nuchal crescent* in both sexes.
5. Throat and fore neck *brown*.
6. Whole top of head and hind neck *gray*.
7. General plumage with an *olivaceous* cast.

Cafer.

- Quills *red*.
 Male with a *red* malar stripe.
 Adult female with (usually) a distinct *brown* malar stripe.
No nuchal crescent in either sex.
 Throat and fore neck *gray*.
 Whole top of head and hind neck *brown*.
 General plumage with a *rufescent* cast.

Characters shared in common by both are :

- | | |
|-----------------------------------|------------|
| 1. General size. | 4. Habits. |
| 2. Proportion of parts. | 5. Notes. |
| 3. General pattern of coloration. | |

In size, in the general pattern of the coloration, in habits and notes, the two species are indistinguishable.

The presence of a nuchal crescent in both sexes in the one and its absence in the other, the striking contrast in the color of the malar stripes, and of the quills of the wings and tail, and the transposition of the colors of the crown and throat, are, however,

not simply differences of degree, but of a radical nature. In fact, no two congeneric species could well present more striking differences as regards coloration.

The manner of the interblending of the characters of the two species in the mixed birds has an important bearing upon the problem of the relationship of the two birds, as regards (1) the way in which the characters of the two species are combined, and (2) the geographical area over which the mixed birds are distributed.

HOW THE CHARACTERS OF THE TWO SPECIES ARE COMBINED.—As has been long known—indeed, as shown by Baird in 1858—the ‘intermediates’ or ‘hybrids’ present ever-varying combinations of the characters of the two birds, from individuals of *C. auratus* presenting only the slightest traces of the characters of *C. cafer*, or, conversely—individuals of *C. cafer* presenting only the slightest traces of the characters of *C. auratus*—to birds in which the characters of the two are about equally blended. Thus we may have *C. auratus* with merely a few red feathers in the black malar stripe, or with the quills merely slightly flushed with orange, or *C. cafer* with either merely a few black feathers in the red malar stripe, or a few red feathers at the sides of the nape, or an incipient, barely traceable scarlet nuchal crescent. Where the blending of the characters is more strongly marked, the quills may be orange yellow or orange red, or of any shade between yellow and red, with the other features of the two birds about equally blended. But such examples are exceptional, an unsymmetrical blending being the rule, the two sides of the same bird being often unlike. The quills of the tail, for example, may be part red and part yellow, the number of yellow or red feathers varying in different individuals, and very often in the opposite sides of the tail in the same bird. The same irregularity occurs also, but apparently less frequently, in the quills of the wings. In such cases the quills may be mostly yellow with a few red or orange quills intermixed, or red with a similar mixture of yellow. A bird may have the general coloration of true *cafer* combined with a well-developed nuchal crescent, or nearly pure *auratus* with the red malar stripes of *cafer*. Sometimes the body plumage

is that of *C. auratus* with the head nearly as in pure *cafer*, or exactly the reverse may occur. Or we may have the general plumage as in *cafer* with the throat and crown as in *auratus*, and the malar stripe either red or black, or mixed red and black, and so on in almost endless variations, it being rare to find, even in birds from the same nest, two individuals alike in all their features of coloration. Usually the first trace of *cafer* seen in *auratus* manifests itself as a mixture of red in the black malar stripe, either as a few red feathers, or as a tipping of the black feathers with red, or with merely the basal portion of the feathers red. Sometimes, however, there is a mixture of orange or reddish quills, while the malar stripe remains normal. In *C. cafer* the traces of *auratus* are usually shown by a tendency to an incipient nuchal crescent, represented often by merely a few red-tipped feathers on the sides of the nape; at other times by a slight mixture of black in the red malar stripe.

THE GEOGRAPHICAL AREA OVER WHICH THE MIXED BIRDS ARE DISTRIBUTED.—In 1858, when Baird described his *Colaptes hybridus*, and for many years after, mixed birds were known only from the upper Missouri and Yellowstone region. Later they were noted from California, and more recently from various points along the western border of the Great Plains, from Texas northward to the British boundary.

Occasional specimens of *C. auratus* from the Atlantic States, showing a few red feathers in the malar stripe, have also been for some time known, but the occurrence of a large proportion of mixed birds in California has only lately been recorded. Yet the distribution of mixed birds, as shown by the material now brought together,¹ proves to be far more extended and general than till now has been supposed. Instead of the mixed birds being comparatively limited in distribution, they are found to have a wide dispersion, occurring, as already stated, with considerable frequency from the eastern border of the Great Plains westward to the Pacific Coast, and from near the Mexican boundary northward to some distance north of the United States, with, however, the area of greatest abundance much more local-

¹ See the accompanying map.

ized. No mixed birds, however, have been seen from any part of Mexico, nor from any part of Arctic America, where in the one case only pure *cafer* is found, and in the other only pure *auratus*.

East of the Mississippi River, from Florida northward and westward to Alaska, *C. auratus* rarely shows any outcropping of the characters of *C. cafer*. Perhaps one male in a thousand (or more probably a still smaller proportion) shows a few red feathers in the malar stripe, varying in different individuals from the faintest perceptible trace to a mixture of one-fourth to one-third red. A single bird from Louisiana (Coll. Gustave Kohn) has the malar stripe wholly red and the whole head nearly as in *cafer*, and a single specimen from Toronto, Canada (Coll. F. E. Thompson, No. 206¹) has the tail about half orange red, with other traces of *cafer* characters; and I have heard of what purports to be the capture of a nearly pure *cafer* specimen in Pennsylvania, but this latter case is not well authenticated. Specimens with a slight amount of red in the malar stripe are represented in the material I have examined from Massachusetts, Long Island, New Jersey (five specimens), Pennsylvania, Virginia, Florida (several), Louisiana (several), Tennessee, Ohio, Indiana, Illinois (several), Michigan (two), and Minnesota. They seem to be quite as frequent along the Atlantic seaboard as at any point east of the Mississippi River. Material from the States immediately west of this line, from Iowa southward, is scanty, but the few specimens seen do not indicate a larger proportion of birds with red in the malar stripe than occur in Florida or New Jersey. It is hence probable that nearly pure *auratus* prevails westward to the eastern border of Texas, the Indian Territory, Kansas, and Nebraska, and over the greater part of both Dakotas and Manitoba. Birds from eastern Texas, eastern Kansas, and eastern Montana, taken in the breeding season, generally, or at least frequently, show some traces of the characters of *cafer*, the malar stripe frequently being more or less mixed with red. In southeastern Texas, and thence northward through middle Texas, and over the Plains to, and doubtless much beyond, the northern boundary of Montana, mixed birds are the rule, the characters of the two species being blended in every conceivable combination, pure *cafer* or pure

¹ See Auk, Vol. II, 1883, p. 335.

auratus being rarely met with, except in winter, when, in consequence of migration, pure *auratus* is more or less frequent in Kansas, the Indian Territory, and Texas, considerably to the westward of its normal limit in the breeding season.¹ At the same time there is an influx into the same region of nearly pure *cafer* from the westward, resulting in a commingling of birds presenting mixed characters with those of normal character.

In western Texas, New Mexico, Arizona, and southern California, the prevailing form in the breeding season is probably nearly pure *cafer*, but in winter the proportion of perfectly pure birds is much smaller, owing to the southward migration of slightly-mixed birds from further north. In a series of over 30 males from Arizona, taken between October 1 and March 30, more than one-third show either traces of black in the malar stripe, or traces of a scarlet nuchal crescent, or both. One female has all the quills orange yellow, but generally the equally large series of females shows no recognizable characters of *auratus*.

In central and western Colorado, Utah, and Nevada, the characters of *cafer* evidently prevail, at least in the breeding season; in eastern Colorado in winter and during migrations mixed birds are the more common, and have been taken in the breeding season at Fort Garland in the same State. Similar specimens have been taken in Utah and Nevada, every one of my series of seven males from Nevada showing traces of the red nuchal crescent, and some of them other characters of *auratus*.

Of Idaho almost nothing is known. The single specimen I have seen is a mixed bird. In Wyoming mixed birds appear to be the rule, with *auratus* characters prevailing in the eastern part of the State and *cafer* characters in the western. The same is apparently true of Montana. Birds from eastern Oregon, eastern Washington, and eastern British Columbia, or from the area east of the Cascades, also present a strong infusion of *auratus* characters; some specimens being two-thirds to three-fourths *auratus* and others nearly pure *cafer*, with rarely a normal bird of either species. The bird of the coast region, from the mouth of the

¹ Mr. H. P. Attwater writes me that at San Antonio "Typical *auratus* is common in winter; the bulk migrate earlier than *C. cafer*. Typical *cafer* is rare; hybrid Flickers of several shades are common. All the forms have been observed migrating together."

Columbia River northward, is *C. cafer saturator*, but a large proportion of the specimens, even from Puget Sound and Vancouver Island, show traces of *auratus* characters, in some instances very prominent traces, even to yellow quills interspersed with red ones. Indeed, Mr. Fannin states that true *C. auratus* occurs as a rare visitor on Vancouver Island and the adjoining mainland.¹

In central and northern California the two forms are as thoroughly mixed as at any point east of the Rocky Mountains, both *auratus* and *cafer* occurring in a nearly pure state, with birds presenting every possible combination of the characters of both species. Of 40 specimens from central California, chiefly from Marin and adjoining counties, three are nearly pure *auratus*, the only feature of *cafer* being a very slight mixture of red in the malar stripe—not more than occasionally occurs in birds from the Atlantic States; six (of which four are females, and hence have less significance) are apparently pure *cafer*; of the remaining 31 *auratus* characters prevail in eight, and *cafer* characters in twenty, with three in which the *cafer* and *auratus* characters are about evenly divided. In San Bernardino, San Diego, and adjoining counties in southern California (I have one specimen of pure *auratus* from Warm Springs) traces of *auratus* characters are rare, while in Oregon, so far as material shows, about the same conditions of mixture occur as are found in central California. Indeed, as most of the California specimens before me were taken either in the autumn or winter, it is fair to conclude that many of them were migrants from further north, probably from Oregon or eastern Washington, since more or less mixed birds occur as far north as Sitka, and even Chilkat. Beyond this point, to the northward and eastward, *cafer* appears to be replaced by pure *auratus*, from which region, through migrants, is doubtless derived the strong infusion of *auratus* characters in the birds of California.

To summarize the foregoing, we find that *cafer* unmixed with *auratus* occupies Mexico, but that very soon after crossing the United States boundary we begin to meet with specimens showing slight traces of the characters of *auratus*, and that as we proceed northward these traces become more frequent and more

¹ Check List of British Columbia Birds, 1891, p. 29.

pronounced, across the whole breadth of the habitat of *cafer*, till north of the United States we pass into the habitat of pure *auratus*. There is also the same blending in passing eastward from the eastern base of the main chain of the Rocky Mountains. Thus the blending is complete along the line of junction of the habitat of the two species, or from southeastern Texas northward along the western edge of the Plains into British America and thence westward in British America to the Pacific Coast in southern Alaska. From this line we may trace the mixed birds westward and southward over nearly the whole range of *cafer* north of Mexico, due apparently from not only the mixing of the two species wherever their habitats adjoin, but through the intrusion, mainly from the northward, of *auratus* into the habitat of *cafer* through the southward migration of *auratus* in winter, some of the latter apparently remaining as summer stragglers to breed.

The conditions here outlined are shown graphically on the accompanying map, compiled primarily from specimens actually examined by the writer, but supplemented to a considerable extent by an examination of the available literature bearing on the subject. An attempt is made to distinguish by the use of different symbols, in the case of not only *C. auratus* and *C. cafer*, but of the intergrades as well, the nature of the record as regards season, as explained on the map itself. The boundary lines are of course to some extent hypothetical.¹

CONCLUSIONS.—The facts elicited in the present investigation tend strongly to confirm Baird's startling hypotheses of hybridization on a grand scale between *Colaptes auratus* and *C. cafer* to account for the occurrence of birds presenting ever-varying combinations of the characters of the two species over the Plateau and Great Basin regions of the continent. None of the other hypotheses thus far advanced so fully, or in fact to any great extent, meet the requirements of the case. In no instance do we meet with stages or methods of geographical variation at all comparable with what is seen in the case of *C. auratus* and *C. cafer*.

¹ The habitats of *C. chrysoides* and *C. cafer* overlap; the lighter line is intended to indicate the northern and eastern boundary of that of the former, the heavy line the southwestern boundary of that of *cafer*.

[March, 1892.]

The transition between geographic forms, however diverse, is gradual and symmetrical, affecting all parts of the plumage equally and simultaneously, and is obviously correlated with changes in the physical surroundings; also the differences between the most extreme forms are merely differences of degree. In the case of *Colaptes* the essential differences between *auratus* and *cafer* are radical; they are, in fact, contrasting characters; and the intergradation is irregular, with all sorts of asymmetrical combinations of the characters of the two forms, and no correlation between their intergradation and the conditions of environment.

In California, British Columbia, Montana, Wyoming, Kansas, and southern Texas, we get the same irregular and multifarious combinations of the characters of the two species. On the other hand, the phenomena of intergradation, as regards both the nature of the intergrades and their geographical distribution, are just what we should expect them to be on the theory of interbreeding. Furthermore, it is a matter of observation that very unlike birds pair together, and that individuals of the same brood are often very diverse in appearance. While I know of no record of pure *cafer* birds being found mated with pure *auratus* birds, that such mating has many times occurred seems beyond question, since this might happen at any point along a line more than a thousand miles in extent where the habitats of the two species adjoin. On either side of this boundary the influence of one species upon the other fades out gradually as the distance from the line increases, till in Mexico, in the United States east of the Mississippi River, and in Alaska and eastern British America, it becomes practically *nil*. The outcropping of *auratus* characters in *cafer* in British Columbia and in the United States west of the Rocky Mountains, and the gradual fading out of this infusion to the southward, can readily be accounted for by the migration of *auratus* from the north into the northern border of the habitat of *cafer*, and the gradual wide dispersion southward of the intermediates resulting from the interbreeding of the two species. The very slight traces of *cafer* characters occurring in rare instances in *auratus* in the East may be readily supposed to be due to the sporadic dispersion eastward of waifs from the habitat of *cafer*,

since it is known that nearly all western birds occasionally stray eastward even to the Atlantic seaboard. The capture near New Orleans and Toronto of strongly marked 'hybrids' shows that at least 'intermediates,' if not representatives of pure *cafer*, stray far to the eastward of their proper habitat.

It is thus unnecessary to suppose that the appearance of a few red feathers in the malar stripe of specimens of *auratus* taken in the Atlantic States indicates a tendency to a reversion to some hypothetical 'ancestral type' which had the malar stripe red, or that the presence of black feathers in the malar stripe, or an incipient scarlet nuchal crescent, in birds from Arizona, Nevada, and southern California, indicates a similar tendency to a hypothetical ancestor which had black malar stripes and a red nuchal crescent; since the slight infusion of *cafer* blood in the one case, and of *auratus* blood in the other, of which we have almost indubitable proof, affords an adequate and satisfactory explanation of these odd phenomena.

The large infusion of *auratus* blood shown in the *Colaptes* stock in Oregon and northern California is easily explained by the fact that *C. auratus*, like many other eastern birds, can find easy access to the northwest coast either by way of the low divide in Wyoming, or from the northward, the habitat of *auratus* reaching the Pacific Coast in northern British Columbia and Alaska.

It is of interest in this connection to note that in the earlier collections from California 'hybrid' Flickers were practically unknown, there being none in the material handled by Baird in 1858. In 1870 Dr. J. G. Cooper considered the capture of two examples of *Colaptes*, taken at Oakland, presenting characters of *auratus*, worthy of special record.¹ But Mr. W. E. Bryant, in Belding's 'Land Birds of the Pacific District,' published in 1890, says that specimens referable to 'hybridus' "are now taken almost as often as *C. cafer*; in fact, it is unusual to get really good examples of *C. cafer* in some localities" (l. c., p. 72). My own series from central and northern California, as already noted, fully bears out this statement. In our standard works on North American birds, even in the latest, the habitat of the so-called 'hybridus' is given as the region of the upper Missouri and

¹ Orn. Cal., I, p. 412.

Yellowstone and the Black Hills. Now, however, we have evidence of the occurrence of mongrel birds in abundance over a belt of country, hundreds of miles wide, extending from the Rio Grande in Texas northward and westward to southern Alaska. Hence one may almost ask whether this does not favor the assumption that *C. auratus* is gradually extending its range into the habitat of *C. cafer*, particularly in California, and along the whole border of the habitat of *cafer*. Unfortunately the evidence favoring this assumption is mainly negative, owing to the deficiency of material from the habitat of *cafer* collected prior to a comparatively recent period.

Finally, it may be added, the intergradation between *Colaptes auratus* and *C. cafer* is not only unique as regards the character and geographical distribution of the intergrades, but is something superimposed upon ordinary geographic variation due to environment, since the ordinary phases of geographic variation, as seen in other birds having the same distribution, is well illustrated in the various North American forms of *Colaptes*, as has already been indicated, and as will be presently shown more in detail.

II.—GEOGRAPHICAL VARIATION.

(1) IN SIZE.—In both *Colaptes auratus* and *C. cafer* there is a marked decrease in size from the north southward.

The average length of the wing in specimens of *C. auratus* from Arctic America is 6.35 in.; in specimens from South Florida, 5.75 in., giving an average difference of .60 of an inch between birds from the extreme north and the extreme south—equal to rather more than 10 per cent. of the average length of the wing in the southern birds. Specimens from near the northern boundary of the United States, from New England and New York westward to Minnesota, are just intermediate in size between the specimens from Arctic America and South Florida, the average length of the wing being 6.12.

The Cuban *Colaptes chrysocaucosus* is still smaller than the Florida birds (wing about 5.55), while *C. gundlachi* from Grand Cayman, is slightly smaller than the Cuban form.

In *C. cafer* geographical variation in size is less uniform, in passing from the north southward, specimens from Chihuahua and Arizona being nearly as large as specimens from Montana and British Columbia, the difference in latitude perhaps being partly offset by the greater elevation of the more southern region. Specimens from southern Mexico, however, are much smaller than those from Chihuahua and Arizona, the wing in eight males averaging 6.07.

C. cafer saturator, from the Northwest Coast, has the average length of the wing about 6.55, while in *C. rufipileus*, from Guadalupe Island, it is about 5.93, or about the same as in specimens from southern Mexico—a difference nearly parallel with that between *C. auratus* from Arctic America and Florida.

C. mexicanoides averages only a little smaller than examples of *C. cafer* from southern Mexico, the former having the wing 6.10, the latter about 6.50.

C. chrysoides presents great constancy in size, there being no very appreciable difference in this respect between specimens from Arizona and the southern part of the peninsular of Lower California. The length of the wing averages about 5.75—the same as in South Florida examples of *C. auratus*, and hence less than in any of the forms of the *C. cafer-mexicanoides* group.

The accompanying table of measurements (see p. 38) shows¹ more in detail the variation in size with locality here summarized.

(2) IN COLORATION.—The geographical variation in coloration in the various forms of *Colaptes* is quite parallel to that in other species of similar distribution, and hence presents nothing especially noteworthy. In *C. auratus* there is a lightening of the colors as we approach the Plains. This is very noticeable even in Minnesota specimens, and still more so in specimens from the Dakotas, Nebraska and Kansas.

It has been suggested that the resident form of South Florida would prove separable as a subspecies from the bird found at large further north, on the basis of its smaller size and darker colors. The average difference, however, as shown by a large

¹ These measurements have been made with great care by Mr. C. B. Isham, an assistant in this department of the Museum, and are hence all strictly comparable with each other.

TABLE SHOWING GEOGRAPHICAL AND INDIVIDUAL VARIATION IN SIZE IN THE NORTH AMERICAN SPECIES OF *Colaptes*.

SPECIES.	LOCALITY.	No. of specimens	Sex.	WING			TAIL			CULMEN.	
				Aver- age.	Max- imum.	Min- imum.	Aver- age.	Max- imum.	Min- imum.	Aver- age.	Max- imum.
<i>C. auratus</i>	Arctic America.....	8	♂	6.37	6.62	6.20	4.26	4.56	4.06	1.44	1.58
".....	".....	6	♀	6.32	6.50	6.18	4.25	4.84	4.14	1.36	1.52
".....	Northern United States....	19	♂	6.15	6.40	5.94	4.09	4.52	3.90	1.40	1.54
".....	".....	18	♀	6.08	6.30	5.80	4.01	4.40	3.70	1.32	1.52
".....	Florida.....	10	♂	5.77	5.92	5.66	3.89	4.10	3.70	1.33	1.38
".....	".....	10	♀	5.72	6.08	5.42	3.81	4.24	3.76	1.29	1.40
<i>C. chrysicaulus</i>	Cuba.....	2	♂	5.67	5.68	5.67	4.19	4.20	4.18	1.35	1.36
".....	".....	3	♀	5.47	5.66	5.32	4.16	4.34	4.00	1.32	1.38
<i>C. cafer</i>	Arizona.....	10	♂	6.53	6.70	6.36	4.45	4.78	4.20	1.43	1.48
".....	".....	10	♀	6.41	6.72	6.20	4.38	4.42	4.04	1.40	1.46
".....	Chihuahua.....	10	♂	6.52	6.70	6.30	4.22	4.52	3.96	1.50	1.62
".....	".....	10	♀	6.46	6.72	6.18	4.34	4.62	3.96	1.49	1.62
".....	Southern Mexico.....	7	♂	6.07	6.52	5.92	4.71	4.86	4.45	1.40	1.45
<i>C. cafer saturator</i>	Brit. Col. and Washington	10	♂	6.55	6.64	6.46	4.56	4.86	4.10	1.56	1.66
".....	".....	10	♀	6.51	6.82	6.36	4.53	4.84	4.16	1.47	1.56
<i>C. rufipileus</i>	Guadalupe Island.....	1	♂	5.94	.....	.....	4.16	.....	.....	1.58	.....
".....	".....	4	♀	5.92	6.20	5.76	4.40	4.50	4.34	1.49	1.60
<i>C. mexicanoides</i>	Guatemala.....	6	♂	6.11	6.24	6.00	4.40	4.50	4.34	1.49	1.60
".....	".....	4	♀	5.96	6.00	5.92	4.27	4.38	4.18	1.39	1.40
<i>C. chrysoides</i>	Arizona.....	8	♂	5.78	5.84	5.70	3.72	4.00	3.62	1.46	1.58
".....	".....	4	♀	5.68	5.80	5.60	3.44	3.60	3.32	1.48	1.68
".....	Triunfo, L. Cal.....	12	♂	5.74	6.92	5.64	3.72	3.94	3.40	1.36	1.40
".....	".....	12	♀	5.64	5.80	5.42	3.65	3.82	3.34	1.34	1.46

amount of material, proves too slight and too inconstant, in either size or color, to make a separation practicable, as is readily shown by comparison of a considerable series of breeding birds from South Florida with a corresponding series from the Middle States or New England. Some of the South Florida birds are not only small, but also exceptionally dark, but the dark color proves to be due in large part to the worn condition of the plumage, consequent upon the breeding season, and in some measure to soiling of the plumage, due apparently to contact with burnt trees. Specimens nearly as dark occur, however, in New Jersey and Massachusetts, so that the average difference in color between Florida and northern birds is not readily appreciable.

C. cafer presents four geographical phases, correlated with very different climatic conditions. First, the pale form, found throughout the arid interior, from Central Mexico northward. Second, the darker, much deeper-colored Northwest Coast form, known as *C. cafer saturation*. Third, a quite similar phase, as regards coloration, but much smaller, from southern Mexico. Fourth, the insular *C. rufipileus* from Guadalupe Island, off the coast of southern California. This closely resembles *saturation* in color, but is much smaller and has a relatively much longer bill.

Attention has previously been called¹ to the small size of the birds from southern Mexico, and also to their resemblance in color to birds from Vancouver.² The specimens before me show that the birds from southern Mexico are not only much smaller than specimens from Chihuahua and Arizona, but they closely resemble in color subspecies *saturation* from the Northwest Coast, a condition of things quite in accord with the well-known lines of geographic variation in other groups, and perhaps justifying Mr. Ridgway's suggestion (l. c.) that it may prove expedient to recognize these small, dark-colored southern birds as a geographic race.

C. mexicanoides may perhaps be almost considered as an extreme southern differentiation of *C. cafer*, in which all the

¹ Ridgway, Man. N. Am. Birds, 1887, p. 296, foot-note.

² Hargitt, Cat. Bds. Brit. Mus., XVIII, 1890, p. 19.

colors and markings are much stronger than in any form of the *C. cafer* group. So far as now known, however, it must take rank as a species instead of a subspecies.

III.—INDIVIDUAL VARIATION, AND VARIATION DUE TO AGE AND SEASON.

(1) INDIVIDUAL VARIATION.—The range of individual variation in the various North American forms of *Colaptes* is rather greater than the average range in other species, especially in respect to color. The variation in size is perhaps sufficiently shown in the table of measurements given on page 38 (compare under each species the columns headed respectively 'maximum' and 'minimum'). The bill varies in length, in the different forms, from 15 to 25 per cent. of the mean; the length of the wing, from 8 to 12 per cent.; the length of the tail, from 12 to 18 per cent. The female, judging from the measurements of about 200 specimens, is rather more variable than the male. While the female averages smaller than the male, the largest bird of a series of specimens, taken at the same locality and at the same season, proves sometimes to be a female, while some of the smallest birds of the series may be males. The tail varies more than the wing, and the bill much more even than the tail.

Individual variation in color affects (1) the size and shape of the circular black spots on the lower plumage, (2) the width and number of the dusky crossbars of the upper plumage, (3) the size and form of the malar stripe, (4) the presence or absence of black spots on the white rump, (5) the tone of color suffusing the general plumage. The last, however, is more or less complicated with seasonal variation.

The pattern of coloration being the same in all the forms, and the extent and character of the variation similar in each, the remarks here following may be understood as applying to the group collectively, unless otherwise stated.

Each feather of the ventral surface, from the pectoral crescent posteriorly, is marked near the tip with a circular spot of black; they are smaller and more nearly circular anteriorly, larger and transversely broader posteriorly. Those of the breast vary

greatly in size and shape in different birds, being sometimes round, sometimes pear-shaped, sometimes transversely oval, and sometimes longitudinally oval. In some birds they are twice as large as in others, varying in different birds from an average diameter of 2 or 3 mm. to an average diameter of 4 or 5 mm., comparing in each case corresponding feathers.

The interscapulars, scapulars, wing-coverts and quills are barred transversely with black. These bars, usually three in number, vary enormously in width in different specimens strictly comparable as regards age, season and locality. The apical bar, for example, has usually a width of about $2\frac{1}{2}$ mm.; the extremes vary from 1 to 4 mm., resulting of course in a very different general effect. Generally speaking, birds with small spots on the ventral surface have narrow bars on the dorsal surface, and conversely; but this is by no means an invariable rule, since birds occur with very large spots on the lower plumage and very narrow bars on the upper plumage, or the reverse. Extreme variations in the size of the spots and bars are especially common in both *C. chrysoides* and *C. cafer*; in *C. auratus* the range of variation is narrower and extreme departures from the normal are less frequent.

The malar stripe varies in form and extent in the male in all the forms, but more in *C. auratus* perhaps than in the others. It is sometimes very broad and at the same time very long, thus greatly exceeding the normal or average extent; sometimes it is very much reduced, occasionally to one-half, and in extreme cases to one-third the normal size. Thus the area may be two to three times greater in some specimens than in others.

There are occasionally indications of a malar stripe in the female. This, however, is very rare in *C. auratus* and *C. chrysoides*, but common in the *C. cafer* group, and the rule in *C. mexicanoides*, where the exceptions are rare. When present in the female it differs greatly in color from the corresponding mark in the male. In *C. auratus* a very small percentage of the females have the area occupied by the malar stripe in the male faintly tinged with grayish, the basal portions of the feathers being dusky and showing slightly at the surface. In one specimen (No. 8308, ♀ ad., Coll. Wm. Brewster), from Ann Arbor, Michigan, the feathers of

the malar area are distinctly black beneath the surface, the black extending quite to the tips of some of the feathers, forming a well-marked incipient malar stripe. This is, however, an extreme case, and almost unique. In another specimen, also from Michigan (Ypsilanti, No. 8306, ♀ ad., Coll. Wm. Brewster), a few of the feathers of the malar region are tipped with black and many others with red, giving rise to a very narrow red malar stripe slightly mixed with black. Otherwise the bird is a normal example of *C. auratus*.

In a very large series of *C. chrysoides* two females show a faint wash of cinnamon at the posterior border of the area colored red in the male. This, however, may be due merely to immaturity, the birds being apparently young of the year, in which a slight trace of the brownish malar stripe is usually present in the female prior to the first molt.

In all the forms of *C. cafer* the adult female has generally an incipient brownish cinnamon malar stripe, sometimes as well defined as is the red malar stripe in the male. In perhaps ten to twenty per cent. of the birds examined it is entirely wanting; in a large proportion it is clearly outlined, but the brownish tint is superficial and more or less mixed with gray; in fully one-third, however, it is as distinct as in the female of *C. mexicanoides*, and nearly as bright in color, being of the same rich cinnamon rufous as the forehead and the superciliary stripe. These variations have evidently no geographical significance, since the whole range of variation here indicated occurs in birds from Montana, British Columbia, Washington, California, Arizona, and Mexico, with the several phases similarly represented at each of these localities.

As regards the tone of color suffusing the general plumage, fall birds from the same locality show a wide range, whatever the species may be, and the same is true of breeding birds. In *C. auratus*, for example, the ground color of the back varies, in fall birds, from hair brown through olive to bistre (*cf.* Ridgway, Nomen. Colors), while the lower surface varies from a strong tinge of yellow to tawny vinaceous. In spring birds the lower surface varies from nearly white to dull vinaceous cinnamon, with a corresponding range of variation in the dorsal plumage.

A male example of *C. cafer saturator* (No. 1160, Coll. Prof. J. Macoun, Burrard Inlet, B. C., April 29, 1887,) is noteworthy on account of having a distinct but narrow supraloral line of *bright red* on each side, meeting in front across the base of the forehead.

(2) SEASONAL VARIATION.—The purely seasonal variation in color results as usual from (1) fading and (2) abrasion. In fall birds the plumage is more heavily suffused with coloring matter, both above and below, and the tints are thus deeper and stronger. During winter there is a gradual loss of color, which proceeds more rapidly during the spring and early summer, simply through fading from exposure, resulting in a marked change in tone. At the same time the edges of the feathers become gradually worn away, till, towards the end of the breeding season, the light-colored apical border has disappeared. This gives greater distinctness and prominence to the black spots below and the dark bars above, which in fresh plumage are partially veiled by the overlapping lighter edges of the feathers. This, with the change in the tone of the ground color, results in a very different general effect, the breeding bird appearing blacker and more heavily spotted and barred than when in fresh autumnal or winter plumage.

Seasonal change of color, due to fading and abrasion, is in general much greater than is commonly recognized, and is a factor to be constantly borne in mind in the comparison of birds from different localities. It is not perhaps greater in *Colaptes* than in many other groups.

(3) VARIATION DUE TO AGE.—Under this head will be given simply a few notes on the first or nestling plumage. In all of the forms the young birds have the whole top of the head more or less red, as in young Woodpeckers generally, through the feathers being narrowly tipped with this color. The amount of red, or the extent of this tipping, varies greatly in different individuals of even the same brood, as does likewise the shade of red, which varies from dull reddish brown to bright brick red. As regards general coloration, the markings are coarser and heavier than in the adults, and the general effect darker.

A feature of special interest in respect to the young in nestling plumage is the variable status of the malar stripe, considered as a secondary sexual character. In *C. auratus* both sexes have the black malar stripe, which in adult birds is confined to the male. In 30 specimens, varying in age from half-grown nestlings to full-fledged birds, *not one lacks the black malar stripe*, while five of them are sexed as females by their respective collectors from anatomical examination of the specimens, and attention is called on the label, to the presence of the malar stripe. While most of the other specimens are marked as males, it is quite certain that they were thus marked on the presumption that a black malar stripe denoted a male, in the young as well as in the adult.

Of four young *C. chrysoides* in first plumage two have the malar stripe red as in the adult male, while the other two have a well-defined *rufous* malar stripe, and are sexed as females by the collector. In young *C. cafer* and *C. cafer saturatus* the sexes are similarly distinguished, the malar stripe in the males being bright red and in the females rufous—in other words, the same as in the adults.

In *C. auratus* and *C. chrysoides* of North America, and in *C. campestris* and *C. agricola* of South America, the adult female lacks the red or black malar stripe (as the case may be) present in the male, while in two other South American species (*C. pitius* and *C. cinereicapillus*) this mark is not only wanting in the female but is only imperfectly developed in the male. Consequently it would seem that, on the theory that secondary sexual characters are first acquired by the male and later transmitted, more or less modified, to the female, the presence or absence of a malar stripe in the female would prove a clue to the genetic relationship of the North American types of the genus. When, however, we find the malar stripe present in both sexes in the young and absent in the adult female, as in the case of *C. auratus*, and present as a rule in the adults of both sexes and absent in the female in first plumage, as in the *C. cafer-mexicanoides* group, this character evidently fails to be of much service as an index to the ancestral relationships of the several forms.

Article III.—DESCRIPTION OF A NEW SPECIES 'OF PEROGNATHUS FROM SOUTHEASTERN TEXAS.

By J. A. ALLEN.

During the last few months the Museum has received a large number of mammals collected in the vicinity of Brownsville, Texas, among which are numerous specimens of a small species of *Perognathus*, apparently hitherto undescribed. It is allied to *P. flavus*, but evidently quite distinct from it, and may be described as follows :

Perognathus merriami, sp. nov.

Externally of the size and general proportions of *P. flavus*, but brighter and more yellowish in coloration, the sides being strongly yellowish or golden instead of pale cinnamon.

Measurements (average of three adult specimens) : Total length, 115 mm. ; head and body, 60 ; tail, 55 ; hind foot, 17 ; ear, 4.

Skull, greatest length, 23 mm. ; basilar length (occipital condyle to incisors), 16.5 ; greatest mastoid breadth, 12.7 ; least intermastoid breadth, 4 ; least interorbital breadth, 5.1 ; length of nasals, 11.5 ; greatest zygomatic breadth, 11.5 ; length of upper tooth row, 3.3 ; breadth of palate at posterior border, 2.8 ; breadth of palate at anterior border, 2.3 ; from hinder edge of palate to inner base of incisors, 6.6 ; length of lower jaw, 12.7 ; height at coronoid process, 4.6.

Type, No. 4445, ♂ ad., Brownsville, Texas, Aug. 10, 1891 ; F. B. Armstrong.

Compared with the El Paso specimens of *P. flavus* (kindly loaned me for examination by Dr. C. H. Merriam), taken Dec. 12-14, 1889, *P. merriami* differs markedly in coloration in its generally brighter yellowish color, particularly along the sides. A comparison of the skulls reveals very marked differences, not only as regards the general form but in the relative size and form of special parts, as shown in the series of figures in Plate III. In *P. merriami* the skull is much larger and disproportionately broader in proportion to the length. The mastoids are shorter and less developed, leaving a much broader intermastoid area, with the interparietal much broader than long, instead of nearly square as in *P. flavus*. The figures represent—for purposes of

comparison, and also to show individual variation—three skulls of *P. flavus*, and six skulls of *P. merriami*, as seen from above, drawn twice the natural size.

In addition to the three El Paso specimens of *P. flavus* mentioned above, I have three from North Beaver River, Indian Territory (near the northern boundary of Texas), and one from Presidio County, Texas, that seem also referable to *P. flavus*.

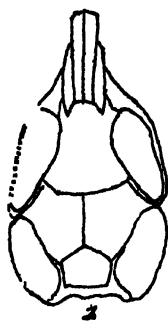
P. merriami is based on a series of 17 specimens from Brownsville, Texas, belonging to this Museum, while a considerable number of additional specimens have passed through my hands. They were taken at various dates covering a period of over four months (July to October, inclusive), and include young and adults. The July and August specimens are a little grayer and less fulvous than those taken late in September and October. In all the tail is naked, and the pelage coarser than in *P. flavus*.

The species is named in honor of Dr. C. Hart Merriam, Chief of the Division of Economic Ornithology and Mammalogy, U. S. Department of Agriculture.

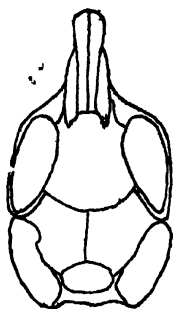
EXPLANATION OF PLATE III.

(All the figures are twice the natural size.)

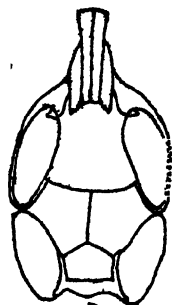
- Fig. 1. *Perognathus merriami*, ♂ ad. No. $\frac{2117}{117}$, Brownsville, Tex., Aug. 4, 1891.
 " 2. " " ♂ ad. No. $\frac{2117}{117}$, Aug. 10, 1891.
 " 3. " " ♀ ad. No. $\frac{2118}{118}$, Sept. 10, 1891.
 " 4. " " ♂ ad. No. $\frac{2119}{119}$, Sept. 6, 1891.
 " 5. " " ♂ ad. No. $\frac{2120}{120}$, Sept. 13, 1891.
 " 6. " " ♀ ad. No. $\frac{2121}{121}$, Oct. 9, 1891.
 " 7. *Perognathus flavus*, No. 2357, Coll. Dr. Merriam, El Paso, Texas.
 " 8. " " ♀ No. $\frac{1889}{1889}$, U. S. Nat. Mus., El Paso, Texas, Dec. 14, 1889.
 " 9. " " ♂ ad. No. $\frac{1889}{1889}$, U. S. Nat. Mus., El Paso, Texas, Dec. 12, 1889.



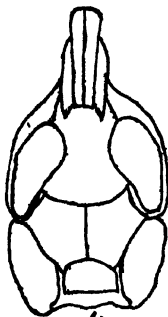
1



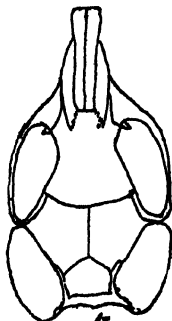
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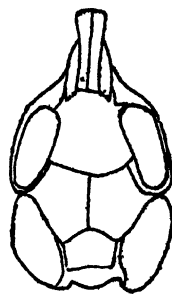
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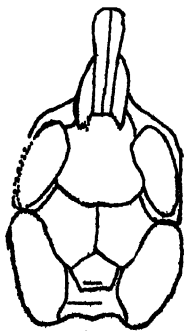
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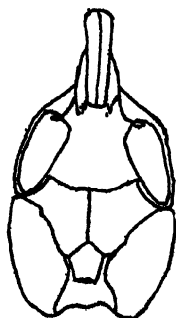
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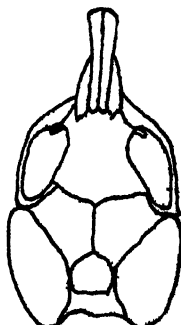
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7



8



9

1-6. *Perognathus merriami*. 7-9. *Perognathus flavus*.
(Twice natural size.)

Article IV.—ON A SMALL COLLECTION OF MAMMALS FROM THE GALAPAGOS ISLANDS, COLLECTED BY DR. G. BAUR.

By J. A. ALLEN.

Dr. G. Baur, of Clark University, Worcester, Mass., has kindly placed in my hands for identification and description, the small collection of mammals recently obtained by him on the Salisbury Expedition to the Galapagos Islands. The collection numbers 12 specimens, representing 4 species. Two prove to be introduced species of *Mus*, while one is a Bat of the genus *Atalapha*, and the other a species of *Oryzomys*, allied to *O. galapagoensis* (Waterh.).

***Atalapha brachyotis*, sp. nov.**

Apparently similar to *Atalapha varia* (Poeppig) from Chili, but rather smaller, with disproportionately smaller ears, and shorter thumb.

General color above reddish chestnut, the hairs plumbeous at base, broadly ringed subapically with yellowish rufous and tipped with chestnut, much darker on the lower back and tail; below blackish with the tips of the hairs ashy. Ears small, rounded, blackish, as also the lips. Wing and interfemoral membranes black, as are also the fingers. Posterior half of the interfemoral membrane very thinly haired.

Measurements.—Head and body, 47 mm.; tail, 44.5; ear, 7.6; tragus, 4.3; forearm, 39; thumb, 6.4; second finger (metacarpal), 42; third finger (metacarpal), 43.2, 1st phal., 16, 2d phal., 16.7, 3d phal., 3=) 79; fourth finger, 63; fifth finger, 53; tibia, 20; foot, 8.4.

Based on a single specimen in alcohol, collected on Chatham Island, June 23, 1891.

As nearly as can be judged, this insular form closely resembles *A. varia* in coloration, size and proportions, except that it has much smaller ears. The hairiness of the interfemoral membrane is apparently similar in both, in *A. brachyotis* there being only a few short hairs beyond the basal half.

Compared with *A. noveboracensis* of North America, aside from the striking color differences, *A. brachyotis* is a much slenderer form; while the linear measurements are about the same, the

body is much smaller, and the wing bones much more slender. There is also a marked difference in the dentition, which is very much slighter, notably shown in the size of the canines, which in *A. brachyotis* are only about half as large as in *A. noveboracensis*.

Dr. Baur writes me : "On Chatham Island, at an elevation of about 1700 feet, where the hacienda is placed, we observed bats nearly every evening, but were for a long time unable to kill a specimen ; the one I send, the only one collected, was shot by Mr. Adams.

"Bats have been observed on Indefatigable Island by Dr Habel, and I observed one on South Albemarle."

***Mus decumanus* Pall.**

Mus jacobia WATERH, Zool. Voy. Beagle, I, pt. ii, 1840, p. 34.

I refer to this species a mummified specimen, "found dead on Albemarle Island, opposite Crowley Island, Aug. 9, 1891." It is an adult, and measures as follows : Head and body, 190 mm. ; tail, 203 ; hind foot, 34. Above the general color is yellowish chestnut, profusely mixed with longer wholly black hairs, passing into yellowish brown on the sides ; below buffy white at the surface, the hairs from near the tips to the base pale sulphery white.

This seems to be the form collected by Darwin (op. cit.) on James Island, where he found it very common, but he does not appear to have actually met with it at any of the other islands.

***Mus rattus* Linn.**

Represented by one specimen in alcohol, about two-thirds grown, apparently not distinguishable from an ordinary black rat of corresponding age. It was taken on South Albemarle, July 29, 1891.

I also refer provisionally to this species an imperfect skeleton found on Duncan Island. This specimen consists of the skull and anterior half of the spinal column, of a full-grown but not aged individual, agreeing in size with *Mus rattus*.

***Oryzomys bauri*, sp. nov.**

Evidently allied to *Oryzomys galapagoensis* (Waterh.), but differing from it in proportions and coloration.

Pelage full and long. General color above dusky grayish brown, faintly varied with pale yellowish brown; below the pelage is white at the surface, passing into plumbeous. Muzzle lighter and more grayish, tinged strongly with yellowish brown on the sides of the muzzle and faintly so on the chin. Ears large, obtusely rounded, almost naked within, well haired externally on the anterior third, and sparsely haired over the rest of the outer surface. Feet above thinly haired, white faintly tinged with yellowish; soles naked, 6-tuberculate; posteriorly smooth and pale horn color, anteriorly granulated and yellowish, slightly varied with gray. Tail indistinctly bicolor, nearly naked, the annulations showing distinctly through the very short hairs; above dusky brown, below ashy brown.

Measurements.—*Male Adult*: Total length, 280 mm.; head and body, 132; tail, 147; hind foot, 32.5; fore foot, 18; ear, 18. *Female Adult*: Total length, 269; head and body, 124; tail, 145; hind foot, 31; fore foot, 16.5; ear, 17.3. *Young Male*: Total length, 248; head and body, 108; tail, 138; hind foot, 16.5; fore foot, 14.5; ear, 16.5.

Skull, ♂ ad.: Total length, 37.4; basal length (condyles to incisors), 27.5; greatest zygomatic breadth, 18.3; least interorbital breadth, 5.6; length of nasals, 13.5; from posterior border of palate to incisors, 14.7; length of lower jaw (tip of incisors to condyle), 22.8; height at condyle, 9.9.

Based on 5 specimens in alcohol, namely, 1 male adult, 1 male two-thirds grown, 1 male half grown, 1 female adult, and 1 female about half grown, taken on Barrington Island, July 9 and 10, 1891. There are also three inverted skins in antiseptic solution, taken at the same place and time. The adult male may be considered as the type.

This species is apparently nearly allied to *O. galapagoensis*, described by Waterhouse from specimens collected by Darwin on Chatham Island, about thirty miles east of Barrington Island. While of about the same size as *O. galapagoensis*, it has larger ears, and the tail is half an inch or more longer than the head and body instead of being an inch or more shorter, as in *O. galapagoensis*. In coloration it is evidently much less varied with yellow, as in *O. galapagoensis*, the prevailing color on the sides of the body is described as yellow. In *O. bauri* the coloration is about as in *Sigmodon hispidus*—the prevailing color being dusky gray, with only the slightest mixture of pale yellowish brown. The young are slightly darker than the adults; the female has a slight mixture of pale yellowish-tipped hairs.

O. bauri, and doubtless also *O. galapagoensis*, is a true *Oryzomys*, as regards the skull and dentition; it has, however, a much

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thicker, longer, and coarser pelage and larger ears than *O. palustris* and its near allies.

Of this species Dr. Baur writes me as follows : " On Barrington Island the small Rodent was pretty common ; it was found between the bushes near the shore, and also high up between grass and the lava rocks."

Of *O. galapagoensis* Darwin writes (Zoöl. Voy. Beagle, I, ii, p. 66) : " This mouse or rat is abundant in Chatham Island, one of the Galapagos Archipelago. I could not find it on any other island of the group. It frequents the bushes, which sparingly cover the rugged streams of basaltic lava, near the coast, where there is no fresh water, and where the land is extremely sterile."

The only other species of mammals thus far reported from the Galapagos Islands are two species of Eared Seals, namely, *Otaria jubata* (Forst.) and *Arctocephalus australis* (Zimm.), specimens of which were obtained in 1872 by the Hassler Expedition (see Allen, Mon. N. Am. Pinnipeds, 1880, pp. 208 and 211). The list of known indigenous species thus numbers only five.

**Article V.—NOTICE OF SOME VENEZUELAN BIRDS,
COLLECTED BY MRS. H. H. SMITH.**

By J. A. ALLEN.

The present small collection, which has recently come into the possession of the Museum, was made by Mrs. H. H. Smith during a brief vacation trip to the northern coast of Venezuela.

The localities visited were Carúpano, on the coast, and El Pilar, a little way in the interior, the time spent at these points being less than ten days—Oct. 30 to Nov. 6, 1891. Although the collection numbers only about 60 specimens, 48 species are represented, several of which appear to be undescribed, and others not previously recorded from Venezuela. For this reason it seems desirable to give a complete list of the species, since the specimens are labeled with the locality and date of capture. It will be of further interest for comparison with Messrs. Sclater and Salvin's list of birds collected at the same points and at the same season of the year by Mr. A. Goering in 1866 (P. Z. S., 1868, pp. 165-173).

1. *Merula fumigata* (Licht.).—El Pilar, ♂ ad., Nov. 3.
2. *Polioptila leucogastra* (Wied).—Carúpano, ♂ ad., Nov. 5.
3. *Dendroica æstiva* (Gmel.).—Carúpano, ♀, Nov. 5.
4. *Setophaga ruticilla* (Linn.).—El Pilar, ♀ ad., Nov. 3.
5. *Euphonia trinitatis* Strickl.—♂ ad.
6. *Tanagra glaucocolpa* (Cab.).—Carúpano, ♂, Nov. 5.
7. *Ramphocœlus atrosericeus capitalis*, subsp. nov.

Adult Male.—Similar to *R. atrosericeus* but smaller, the crimson of head, neck and breast much lighter, and extending much lower on the chest, with a distinct wash of crimson over the whole dorsal and ventral surfaces, nearly as in very dull-colored examples of *R. jacapa*; wings and tail velvety black, darker than in *R. atrosericeus*.

Adult Female.—Similar to the female of *R. atrosericeus*, but the lower parts and rump of a much stronger, clearer red, and the dusky portions of the plumage darker.

Measurements.—*Male*: Length, 6.55 in.; wing, 3.15; tail, 3.05; culmen, .60. *Female*: Length, 6.80 (skin evidently too long); wing, 3.15; tail, 3.08; culmen, .62.

Types, No. 56,195, ♂ ad., and 56,196, ♀ ad., El Pilar, Venezuela, Nov. 5, 1891; Mrs. H. H. Smith.

This subspecies is in some respects intermediate between *R. jacapa* and *R. atrosericeus*, agreeing with the former in size, and somewhat in the faint wash of crimson over the whole dorsal and ventral surfaces, but in general features is more decidedly allied to *R. atrosericeus*, with the differences of coloration distinguishing this species from *R. jacapa* more strongly emphasized. The red of the throat and head is much lighter (scarlet rather than crimson), giving greater contrast between the color of the head and back, thus suggesting the name *capitatis* selected for its designation. Its close affinity with *R. atrosericeus* is thus unquestionable, the color differences in other respects suggesting an exceedingly high-colored, small *R. atrosericeus*. The coast of Venezuela, however, is far to the northward of any point whence any form of *atrosericeus* has hitherto been reported, the habitat of this species being given as Bolivia and southern Peru. It also extends eastward into Matto Grosso, Brazil.

8. *Tachyphonus rufus* (Bodd.) = *T. melaleucus* auct. (See Bull. Am. Mus. Nat. Hist., III, No. 2, 1891, p. 359) Carúpano, ♂ ad., Nov. 1, ♀ ad., Oct. 31; El Pilar, Nov. 3.—These specimens differ from our large Chapada (Matto Grosso) series in being much smaller with an absolutely larger bill; the male is more lustrous, with the white at the base of the inner webs of the wing-quills much more restricted. Doubtless a large series would show a well-defined average difference.

9. *Nemosia guira* (Linn.).—El Pilar, ♂ ad., Nov. 3.
10. *Buarremon*, sp. nov.?—Carúpano, juv., Nov. 5.
11. *Saltator olivaceus* Cab.—El Pilar, ♂, Nov. 5.
12. *Saltator albicollis* Vieill.—Carúpano, ♀, Nov. 1.
13. *Euethia bicolor* (Linn.).—Carúpano, ♂, Nov. 5.
14. *Cardinalis phoeniceus* Bon.—Carúpano, ♀, Nov. 5.

15. *Coryphospingus pileatus* (Wied).—Carúpano, two females, Nov. 1.

16. *Cassicus persicus* (Linn.).—El Pilar, ♂ ad., Nov. 6.

17. *Icterus xanthornus* (Gmel.).—Carúpano, ♂ and ♀ ad., Nov. 1.

18. *Lampropsar tanagrinus* (Spix).—El Pilar, “♂” and “♀,” Nov. 5.

These specimens measure as follows: Length (skin), 7.50–7.75; wing, 3.50–3.55; tail, 3.40; culmen, .68. Two specimens labeled “Napo,” in the Lawrence Collection (the only other specimens I have), measure as follows: Length (skin), 8.50; wing, 4.20–4.45; tail, 4.25–4.30; culmen, .80. The El Pilar birds are thus nearly one-third smaller than the Napo specimens (wings and tail nearly one inch shorter); they also differ in color, the El Pilar birds being nearly uniform deep black, with a slight greenish tinge, instead of the slight purplish cast seen in the Napo specimens. The tail also is much less graduated. There is thus about the same difference in size, and much more difference in color, between these two forms as there is between *Molothrus cabanisi* and *C. atronitens*. Whether these differences are simply individual, or perhaps sexual, or whether they characterize well-marked geographical forms, can not be determined without access to much additional material. Should the two forms prove separable, the Napo form will require a new name, as *Lampropsar guianensis* Cab. is without doubt a synonym of *L. tanagrinus*.

19. *Lophotriccus subcristatus*, sp. nov.

Allied to *L. spicifer* (Lafres.) of upper Amazonia, but much smaller (wing 1.65 instead of 2.00, tail 1.40 instead of 1.60), elongated blackish crest feathers shorter and edged with grayish green instead of grayish white, and the general coloration more greenish above, and more greenish yellow below. One specimen (sexed ♀) El Pilar, Nov. 3.

20. *Hapalocercus fulviceps* ? (Sch.).

One adult specimen, sexed ♂, in molt, Carúpano, Nov. 5. Size of *H. fulviceps* or slightly smaller; wing-coverts and quills more broadly edged with fulvous, but apparently not otherwise

different. If the same as *H. fulviceps* it extends the known range of the species far to the eastward and northward of previous records (western Ecuador and Peru).

21. *Mionectes oleagineus* (Licht.).—Two males, El Pilar, Nov. 5. Apparently not different from Bogota specimens.

22. *Ornithion pusillum* (Cab. & Heine).—Carúpano, Nov. 5. Two specimens, adult and young, both rather larger than the measurements usually given for this species. Wing, 2.12 and 2.25; tail, 1.90 and 1.92; culmen, .34 and .38; tarsus .66. The younger specimen is the larger, and differs much from the other in color, the general color above being more brownish olive, and the wing bars very much broader, and strong buff instead of clear whitish. The adult is in worn plumage, the young bird in fresh unworn plumage, which apparently satisfactorily explains the difference in coloration. The bill in the young bird, however, is much broader and deeper than in any example of *Ornithion* I have seen (compared with a series of 26 specimens).

23. *Sublegatus glaber* Scl.—Two specimens, Carúpano, Nov. 1 and 5. Provisionally referred to this species. Throat and whole breast pure deep gray, scarcely appreciably lighter on the throat; whole belly, crissum and under wing-coverts bright sulphur yellow; above with a strong wash of olive; wing-coverts and quills and outer tail-feathers edged with olivaceous gray, the former very broadly. These specimens are in fresh plumage, which may account for their strong tints, both above and below. The gray of the breast and throat and the yellow of the under parts is much purer and deeper than on the corresponding parts of *Elanlea affinis* Burm.

24. *Myiozetetes texensis* (Giraud).—El Pilar, ♂, Nov. 5.

25. *Rhynchocyclus sulphureus* (Spix).—El Pilar, ♂, Nov. 5.

26. *Pitangus sulphuratus* (Linn.).—El Pilar, ♀, Nov. 5.

27. *Myiodynastes audax* (Gmel.).—El Pilar, Nov. 5, one specimen.

28. *Contopus brachytarsus* (Scl.).—Carúpano, ♂, Oct. 30.

29. *Pipra aureola* Linn.—El Pilar, ♂, Nov. 6. "Legs and feet light purple."

30. *Tityra cayana* (Linn.).—El Pilar, ♀ ad., Nov. 3.

31. *Pachyrhamphus niger* Spix.—El Pilar, ♂, Nov. 3.

32. *Dendroornis susurrans* (Jard.).—El Pilar, Nov. 5, one specimen.

33. *Thamnophilus major* Vieill.—El Pilar, ♂, Nov. 3.

34. *Thamnophilus doliatus* (Linn.).—Carúpano, ♂ juv., Oct. 30.

35. *Formicivora intermedia* Cab.—Carúpano, Oct. 30 and Nov. 3, one ♂ ad. and two females.

36. *Doleromya fallax* (Bourc.).—Carúpano, ♂, Nov. 5.

37. *Chrysolampis moschitus* (Linn.).—Carúpano, ♂ juv., Nov. 6.

38. *Amazilia erythronota* (Less.).—Carúpano, two specimens, Nov. 5 and 6.

39. *Melanerpes subelegans* (Bon.)=*Picus tricolor* Wagler, 1829, not *Picus tricolor* Gmel., 1788).—Carupano, ♂, Oct. 30.

40. *Dryobates kirki* (Mahl.).—El Pilar, ♀, Nov. 6.

41. *Picumnus obsoletus*, sp. nov.

Adult Male.—Above yellowish olive-brown, with faint subapical very narrow dark brown bars; wing-coverts olive brown, lighter yellowish apically and narrowly tipped with blackish; quills dark brown, the secondaries broadly edged externally with light greenish yellow; nasal plumes soiled white tipped with black; whole upper surface of head black, the crown spotted with orange red and the occiput with minute rounded spots of white, extending forward on sides to eyes; below yellowish, lighter or more whitish on the throat, each feather edged apically with a very narrow bar of black, nearly obsolete except on the breast; under wing-coverts strongly buffy white.

Length (skin), 3.35 in.; wing, 1.95; tail, 1.05; culmen, .46; tarsus, .50.

Type, No. 56,158, ♂ ad., El Pilar, Nov. 5, 1891; Mrs. H. H. Smith.

This species finds its nearest ally in *P. squamulatus* Lafr., from which it differs in smaller size, much more yellowish coloration, both above and below, and in the nearly obsolete squamation

of both the upper and lower surface, resulting in a very strongly pronounced difference in general coloration. (Compared with Bogota specimens of *P. squamulatus*.) Its next nearest ally is doubtless *P. undulatus* Hargitt, from which, however, it seems obviously distinct.

42. *Galbula ruficauda* Cuv.—Carúpano, ♂, Oct. 30.
43. *Bucco macrorhynchus* (Gmel.).—El Pilar, ♂, Nov. 2.
44. *Trogon viridis* Linn.—El Pilar, ♂, Nov. 3.
45. *Ceryle americana* (Gm.).—El Pilar, ♀, Nov. 5.
46. *Psittacula guianensis* (Swain.).—Carúpano, ♀, Nov. 5.
47. *Scardafella squamosa* (Temm.).—Carúpano, ♀, Nov. 6.
48. *Columbigallina passerina* (Linn.).—Carúpano, ♂, Nov. 5.

Article VI.—DESCRIPTION OF A NEW GALLINULE, FROM GOUGH ISLAND.

By J. A. ALLEN.

Gough Island is situated in lat. $40^{\circ} 19' S.$, long. $9^{\circ} 44' W.$, about 200 miles southwest of the Cape of Good Hope, and about the same distance east of Tristan d'Acunha, respectively the nearest land to Gough Island. It is a mere volcanic islet, about seven miles long by three to four wide, and rises to a height of 4380 feet. Little seems to be known of its natural history.

The species here described is based on three skins, in fair condition, collected by Mr. George Comer, after whom the species is named. The specimens were sent to me, with other South Sea birds, for identification, by Mr. G. E. Verrill, of New Haven, Conn., through whose courtesy I am permitted to publish the following description :

***Porphyriornis comeri*, gen. et. sp. nov.**

Similar in size and general structure to *Gallinula nesiotis* Scl., from Tristan d'Acunha, but differing from it in coloration, especially through the greatly reduced amount of white on the edge of the wings and on the flanks.

Head and neck dull black ; back brownish black, with, in some of the specimens, a faint tinge of olive ; wings similar, but less brown, with barely a trace of white on the inner surface of the carpus and on the edge of the wing at the base of the first primary, the outer vane of which is minutely edged with whitish ; lower surface of the body slaty black ; three of the flank feathers on each side with a narrow shaft-streak of white near the tip ; lower tail-coverts white ; crissum black. Frontal shield and basal half of bill scarlet ; apical third of bill bright yellow. Legs and feet yellow, varied with reddish ; lower third of tibia deep red. A well-developed light-colored spine at the bend of the wing.

Bill, from rictus, 1.10 to 1.25 ; depth of nostril, .50 ; width at nostril, .30 ; wing, 5.40 to 5.80 ; tail, 2.60 ; tarsus, 1.85 to 2.10 ; middle toe, 2.72 to 2.88.

Type, No. 56,701, Am. Mus. Nat. Hist., Gough Island, collected by Mr. George Comer. (Received in exchange from Mr. G. E. Verrill.)

In measurements this species agrees with *G. nesiotis*, except in the length of the tail, which is 2.60 in each of the three specimens instead of 3.30, as given by Sclater for *G. nesiotis*. The general coloration appears to be much darker, and the white on

the carpus and edge of the wing is nearly obsolete, as are the white flank stripes, which, in *G. nesiotis*, Mr. Sclater says, are nearly as in *G. chloropus*. (See P. Z. S., 1861, p. 261, pl. xxx.) It agrees with *G. nesiotis* in its stout, thick bill and tarsi, short wings and inability to fly.

Mr. Comer, in his MS. notes, calls these birds "Mountain Cocks," and says: "They cannot fly and only use their wings to help them in running.... They are quite plentiful and can be caught by hand. Could not get on a table three feet high. The bushes grow on the island up to about 2000 feet, and these birds are found as far up as the bushes grow.... Tip of bill bright yellow, scarlet between the eyes. Legs and feet yellow, with reddish spots."

Mr. Verrill informs me that Mr. Comer obtained four skins of this species, which came in bad condition, having been merely preserved with salt. Mr. Comer was second mate of the sailing schooner 'Francis Adams.' When the party left Gough Island they took with them six live birds of this species, four of which died, in consequence of getting wet with salt water, soon after being taken on board the schooner; the other two reached this country alive, and after their arrival improved in health and flesh. They were kept tethered by a rope-yarn tied to the leg, and eventually both escaped.

A further account of the habits of this species will be published by Mr. Verrill, based on Mr. Comer's notes, in a general paper on Mr. Comer's collection of South Sea birds.

These two flightless, insular species of *Gallinules* seem well entitled to separate generic recognition. They combine the coloration of *Gallinula* with the short, thick bill and oval nostrils of *Ionornis*, and the stout feet of *Porphyrio*, with the added distinction of a greatly reduced wing, and the resulting inability to fly. I propose for this group the generic name **Porphyriornis**, with *P. comeri* as the type, to which may be referred *P. nesiotis* (*Gallinula nesiotis* Scl.).

**Article VII.—LIST OF TYPES OF SOME SPECIES OF
LEPIDOPTERA, DESCRIBED BY GROTE AND
ROBINSON, IN THE AMERICAN MUSEUM OF
NATURAL HISTORY.**

By WILLIAM BEUTENMÜLLER.

In the present paper I desire to place on record a list of some of the types of the species of Lepidoptera described by Mr. A. R. Grote and the late Coleman T. Robinson. The specimens were donated to the Museum some years ago by Mr. Robinson, who, as far as I have been able to ascertain, also deposited a duplicate set of his *Tortricidæ*, as well as some of the types of the species which he described in conjunction with Mr. Grote, in the Museum of the Academy of Natural Sciences of Philadelphia. Dr. Henry Skinner and Prof. John B. Smith inform me that some of these types are still there, but that some of them have become lost.

All the species mentioned in this paper are labeled in Mr. Grote's handwriting, except where otherwise stated.

LYCÆNIDÆ.

Thecla lorata G. & R., Trans. Am. Ent. Soc., Vol. I, p. 171.—One female, from Virginia, labeled by Robinson.

Thecla inornata G. & R., l. c. p. 323 (= *T. calanus*).—One specimen, from New York, labeled by Robinson.

Thecla henrici G. & R., l. c. p. 174.—One example, from Pennsylvania, labeled by Robinson.

SPHINGIDÆ.

Hæmorrhagia gracilis G. & R., Proc. Ent. Soc. Phil., Vol. V, p. 26, pl. iii, figs. 1, 2 (= *Hemaris gracilis*).—One male, from Canada, labeled by Robinson.

Hæmorrhagia floridensis G. & R., Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 439, pl. xvi, fig. 20 (= *Hemaris floridensis*).—One male, from Florida.

Hæmorrhagia buffaloensis *G. & R.*, l. c. p. 437, pl. xvi, figs. 18, 19 (= *Hemaris buffaloensis*).—One male, from New York.

Hæmorrhagia thysbe var. **uniformis** *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 181 (= *Hemaris thysbe* var. *uniformis*).—One female, without locality.

Philampelus linnei *G. & R.*, Proc. Ent. Soc. Phil., Vol. V, p. 34, pl. iii, fig. 3.—Three examples, from Cuba, with label in Robinson's handwriting.

ZYGÆNIDÆ.

Alypia mariposa *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 329, pl. vi, fig. 40.—One female, from California.

Alypia dipsaci *G. & R.*, l. c. p. 327, pl. vi, fig. 37.—One female, from California.

Alypia sacramenti *G. & R.*, l. c. p. 327, pl. vi, fig. 38.—One female, from California.

Euscirrhopterus gloveri *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 185 (= *Copidryas gloveri*).—One female, in rather poor condition, but still recognizable.

Melanchroia regnatrix *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 441, pl. xvi, fig. 5.—One male and one female, with Robinson's label.

Charidea bivulnera *G. & R.*, l. c. p. 365, pl. xiii, fig. 2.—I am not positive that the single male from Mexico, without a label, which I have before me is the type. It agrees in all particulars with the description and figure of the species, and being from the Robinson collection it is probably the type.

BOMBYCIDÆ.

Arctia achaia *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 334, pl. vi, figs. 45 and 46.—One male and one female, from California.

Arctia mexicana *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 369, pl. xiii, fig. 3.—Three males, from Mexico.

Parorgyia clintonii *G. & R.*, Proc. Ent. Soc. Phil., Vol. VI, p. 3, pl. i, fig. 2 and 3.—One male and one female, labeled by Robinson.

Parorgyia parallela *G. & R.*, l. c. p. 5, pl. i, fig. 5.—Male and female, labeled by Robinson.

Parorgyia cinnamomea *G. & R.*, l. c. p. 6, pl. i, fig. 6.—Three males and one female, labeled by Robinson.

Parorgyia obliquata *G. & R.*, l. c. p. 4, pl. i, fig. 4.—Three females, from Rhode Island, labeled by Robinson.

Datana integerrima *G. & R.*, l. c. p. 13, pl. ii, fig. 4.—One male, from New York, labeled by Robinson.

Datana angusii *G. & R.*, l. c. p. 9, pl. ii, fig. 1.—Two males, from New York.

Heuretes picticornis *G. & R.*, *Trans. Am. Ent. Soc.*, Vol. II, p. 190.—One female and cocoon. It was described from the West Indies.

Sisyrosea inornata *G. & R.*, *Ann. Lyc. Nat. Hist.*, N. Y., Vol. VIII, p. 372.—One female, from Pennsylvania. The specimen is without a label, but is one of the original specimens, and doubtless one of the types.

Adoneta pygmæa *G. & R.*, *Trans. Am. Ent. Soc.*, Vol. II, p. 189.—Three males, from Texas, with printed label.

Psephopæctes simulatilis *G. & R.*, l. c. Vol. I, p. 6, pl. i, fig. 1.—One male, from Mexico, somewhat faded, but still recognizable.

Heterocampa pulverea *G. & R.*, l. c. p. 185, pl. iv, fig. 32.—One female, from Pennsylvania. The probable male of this species mentioned by Grote and Robinson (l. c. p. 186) is also in the collection.

Heterocampa elongata *G. & R.*, l. c. p. 184, pl. iv, fig. 30.—One female, from Pennsylvania, with label printed.

Heterocampa brunnea *G. & R.*, l. c. p. 180, pl. iv, fig. 28.—One female, from Pennsylvania, with label printed.

Citheronia mexicana *G. & R.*, *Ann. Lyc. Nat. Hist.*, Vol. VIII, p. 382, pl. xiii, fig. 1.—One female, from Mexico, labeled by Robinson.

PYRALIDÆ.

Asopia anthœcioides *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 15, pl. ii, fig. 9.—Three males, from New York.

Siparocera nobilis *Rob.*, GROTE, Ann. Lyc. Nat. Hist., N. Y., Vol. II, p. 128.—Four males, from Pennsylvania, labeled "*Callocera nobilis*" by Robinson.

Botys unimacula *G. & R.*, Trans. Am. Ent. Soc., Vol. I, p. 14, pl. ii, fig. 8.—One male, labeled by Robinson.

Botys laticlavia *G. & R.*, l. c. p. 17, pl. ii, fig. 12, ♂.—One male, from Pennsylvania.

Botys deffissa *G. & R.*, l. c. p. 19, pl. ii, fig. 16 (= *B. tyralis* Guen.).—One male, from New Orleans.

Botys haruspica *G. & R.*, l. c. p. 19, pl. ii, fig. 14, ♂ (= *B. acronialis* Walk.).—Three males.

Botys generosa *G. & R.*, l. c. p. 20, pl. ii, fig. 10, ♂ (= *B. orphisalis* Walk.).—One male, from Pennsylvania.

Botys ventralis *G. & R.*, l. c. p. 21, pl. ii, fig. 23, ♂ (= *B. argyralis* Hb.).—One male and one female, from Pennsylvania.

Botys posticata *G. & R.*, l. c. p. 22, pl. ii, fig. 25, ♂ (= *B. similalis* Guen.).—One male, from Pennsylvania, labeled by Robinson.

Botys citrina *G. & R.*, l. c. p. 23, pl. ii, fig. 20, ♀ (= *B. helvialis* Walk.).—One female, from Pennsylvania.

Botys marculenta *G. & R.*, l. c. p. 23, pl. ii, fig. 21, ♀ (= *B. oblitalis* Walk.).—One female, from Pennsylvania.

Botys insularis *G. & R.*, l. c. p. 24, pl. ii, fig. 24, ♂.—One male, from Cuba.

Botys coloradensis *G. & R.*, l. c. p. 25, pl. ii, fig. 18.—One female, from Colorado.

Botys gracilis *G. & R.*, l. c. p. 25, pl. ii, fig. 15 (= *Blepharomastix ranalis* Guen.).—One female, from Pennsylvania.

Botys adipaloides *G. & R.*, l. c. p. 26, pl. ii, fig. 19.—Fine examples, from Pennsylvania, Texas and Virginia, labeled by Robinson.

Botys fabrefacta *G. & R.*—Two males, from Pennsylvania. No description of this species was published; it is probably some well-known species.

Botys plectilis *G. & R.*, l. c. p. 27, pl. ii, fig. 17 (= *B. tertialis* Guen.).—One female, from Pennsylvania, labeled by Robinson.

Pantographa limata *G. & R.*, Ann. Lyc. Nat. Hist., N. Y., Vol. VIII, p. 464, pl. xvi, figs. 16 and 17.—Two males, from West Virginia, labeled by Robinson.

TORTRICIDÆ.

All the following specimens are provided with labels in Robinson's handwriting:

Teras trisignana *Robs.*, Trans. Am. Ent. Soc., Vol. II, p. 282, pl. vii, fig. 69.—One female, from West Virginia.

Teras deflectana *Robs.*, l. c. p. 283, pl. vii, fig. 71.—Two females, from Pennsylvania.

Teras inana *Robs.*, l. c. p. 281, pl. vii, fig. 65.—One example, without locality.

Teras nigrolinea *Robs.*, l. c. p. 281, pl. vii, fig. 67.—Two males.

Tortrix gurgitana *Robs.*, l. c. p. 263, pl. iv, fig. 16 (= *Cacæcia purpurana* Clem.).—Two females, from Illinois.

Tortrix fumosa *Robs.*, l. c. p. 268, pl. iv, fig. 19 (= *Cacæcia fractivittana* Clem.).—One female, without locality. It was described from Ohio.

Tortrix zapulata *Robs.*, l. c. p. 264, pl. i, fig. 7.—Two males, from Illinois.

Tortrix furvana *Robs.*, l. c. p. 265, pl. i, fig. 9 (= *Cacæcia argyrospila* Walk.).—One example.

Tortrix parallela *Robs.*, l. c. p. 267, pl. iv, fig. 17 (= *Cacæcia parallela*). Two males, from Pennsylvania.

Tortrix palludana Robs., l. c. p. 275, pl. vi, fig. 45 (= *Cacæcia fervidana* Clem.).—Two males and two females, from Pennsylvania.

Tortrix lamprosana Robs., l. c. p. 264, pl. i, fig. 5 (= *Pandemis lamprosana*).—Two females, from Pennsylvania.

Tortrix limitata Robs., l. c. p. 264, pl. i, fig. 5 (= *Pandemis limitata*).—One male and one female, from Pennsylvania.

Tortrix pallorana Robs., l. c. p. 266, pl. i, fig. 13.—Three males and two females, from Illinois.

Tortrix nigrida Robs., l. c. p. 268, pl. iv, fig. 20 (= *T. fumiferana*).—Two males.

Tortrix violaceana Robs., l. c. p. 271, pl. v, fig. 31 (= *Enectra violaceana*).—One specimen.

Tortrix caryæ Robs., l. c. p. 270, pl. iv, fig. 26 (= *Dichelia caryæ*).—One male, from Illinois.

Tortrix pettitana Robs., l. c. p. 269, pl. iv, fig. 22 and 23 (= *Cenopsis pettitana*).—One male and two females.

Tortrix irrorea Robs., l. c. p. 274, pl. v, fig. 44 (= *Enectra irrorea*).—One specimen, probably a male.

Conchylis 5-maculata Robs., l. c. p. 284, pl. viii, fig. 76.—One example.

Conchylis angulatana Robs., l. c. p. 286, pl. viii, fig. 81.—Two examples, from West Virginia.

Conchylis argentilimitana Robs., l. c. p. 287, pl. viii, fig. 82.—One example, from Pennsylvania, in poor condition, and barely recognizable.

Conchylis labeculana Robs., l. c. p. 287, pl. viii, fig. 83.—One specimen, from Pennsylvania.

Article VIII.—ON THE EARLIER STAGES OF SOME SPECIES OF NORTH AMERICAN MOTHS.

BY WILLIAM BEUTENMÜLLER.

While collecting entomological specimens in the vicinity of New York City, for the Museum, during the summers of 1889-'90, I have been enabled to make the following observations on the earlier stages of some moths. I am aware that I have been anticipated by other entomologists in some of the notes which follow, yet the most part, as far as I am aware, have not been heretofore recorded :

***Phlegethontius celeus* Hub.**

Some larvæ of this species are brownish black, instead of green, which is their usual color, and have the irrorations yellow, as are also the oblique and lateral stripes, the caudal horn being black. The face in this variety has the centre always paler than the sides. Spiracles velvet black with a lilac ring.

***Anisota stigma*, A. & S.**

After Second Moul.—Body color brownish black. Head bright orange red. At the base of all the spines and over the body irregularly are numerous white irrorations. There are no other markings. The spines on the segmental processes are also white. Length, 25 mm.

After Third Moul.—There is little change, except that the color is now brownish black and the spines have the same white irrorations. Length, 35 mm.

Full-grown Larva.—Body color reddish brown. Head testaceous or chestnut. Each segment with six rather long black spines, and the whole of the segments covered with white warty irrorations, almost tubercular, those on the dorsum being the

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largest. Spiracles jet black with whitish ring and a whitish streak in the centre. Anal extremities with testaceous tinge. Feet and legs reddish testaceous. Length, 60 mm.

Food-plants.—Oak, Chestnut, Hazel.

Pupa.—Very rough and deeply punctured. The segments are surrounded by large series of spines, those in front of the segments the largest. On the posterior edge a row of small spines. Cremaster long, bifurcate at tip. Length, about 30 mm.

Anisota senatoria A. & S.

Egg.—The eggs, deposited on the underside of a leaf, are ovate, flattened and attached by the widest space. They are dull white, changing to slate and afterwards to almost black. After exclusion of larva, the eggs are brightly opalescent. Width, 1 mm.; height, .5 mm.

Young Larva.—Head jet black, shining. Body dull cream color; the segments having a corrugated appearance. On the third segment are two very long spinous processes, directed a little forward, jet black; on the eleventh, twelfth and thirteenth segments are a few very small black dots, not visible without a lens. In the middle of these segments there is also a dark shade. The feet are jet black; abdominal legs concolorous with the body. In the centre of the second segment is a very narrow black line. In feeding, as the body is filled with food, it becomes dusky. Length, 6 mm.

After First Moul.—Jet black, with two narrow, waved, yellowish lines on the lateral region and a broader waved line above the base of the legs. Head and anal segment jet black.

After Second Moul.—The body is now slightly olive, with the lines more distinct and brighter in color. The space immediately below the spiracles is orange brown. Length, 22 mm.

After Third Moul.—Body now jet black, with the lines very distinct and the spinose tubercles longer and rougher; those of

the anal segment being now more numerous and spinose. Length, 31 mm.

After Fourth Molt.—Body color jet black. Head with deep fovea, triangular over the mouth parts. Cervical shield black. Two dorsal and one subdorsal stripes of dull orange, slightly waved and broken. One broader lateral stripe and one stripe enclosing the spiracles of the same color, and a ventral stripe a little paler. Spines and legs all jet black, as is also the anal segment. Length, 38 mm.; length, when fully grown, 55 mm.

Food-plants.—Oak, Chestnut.

Ichthyura vau Fitch.

Before Last Molt.—Head pale chestnut. Body clothed with short hairs; dorsal region greenish white, transversed by three lines of pale reddish brown; lateral region reddish brown, marbled with white. Spiracles black. On the third and on all the segments thence to the ninth are two pale yellow tubercular spots, placed at the anterior junction of the segments. These are lost on all the posterior segments, or, at least, but indistinctly seen.

Full-grown Larva.—Entirely greenish white, with all the markings very much fainter than in the previous stage, except the yellow tubercular spots, which are now much more distinct and continued in a series of eight around the anterior segments. Length, 27 mm. September 24, on Willow (*Salix babylonica*).

Gluphisia trilineata Pack.

Full-grown Larva.—Pale apple green, with a broad subdorsal stripe of lemon yellow. Spiracles, indicated by a yellow shade, and above these a very faint yellow line. The head has two very minute black dots on each side of the mouth parts. Some individuals differ from the one just described by having on the third, fourth, eighth, ninth, tenth and following segments a transverse pinkish band in the middle and surrounded by whitish. In all other respects similar to the former.

Food-plant.—Willow (*Salix*), September 24.

Adoneta spinuloides *H. S.*

The larva varies considerably in the dorsal region, passing from bright scarlet through pale pink, and in some cases assuming on the dorsum the pale-green ground color.

Acontia delecta *Walk.*

Full-grown Larva.—Ground color, dark chocolate brown, almost black. Head pinkish white with black blotches, and on the posterior portion are two orange blotches. Segments two, three and four have four orange patches on the edges of which are black piliferous tubercles. On the other segments the orange patches are much larger and of various shapes, those of the hinder segments being on the dorsum a double oval. From the fifth segment along the lateral region is a row of clear white patches, broken into twos and threes, and enclosing also velvet black tubercular spots. The body is slightly swollen anteriorly, narrowing gradually to the anal segment. Feet and legs black, spotted at their base with orange and white. Length, 35 mm.

Food-plant.—Marsh-mallow (*Hibiscus moscheutos*).

Panopoda carneicosta *Guen.*

After Fourth Molt.—Body color yellowish green, the segments covered with very fine blackish-brown waved lines, giving a rather dirty appearance to the larva. These lines are composed of irrations, and leave the dorsum with a single line and a double subdorsal. Head paler than the body, with a yellow line at the back on the posterior portion. Mouth parts, feet and legs orange, as are also the anal casps, which are long and very widely spread.

Full-grown Larva.—The body color is now a little darker. The band across the head is now united to the subdorsal line and forms a continuous line. There also eight oblique yellowish-white lines on the lateral region. Length, 40 mm.

Food-plants.—Oak, Hickory, Willow.

***Panopoda rufimargo* Guen.**

Full-grown Larva.—Paler green than *Panopoda carneicosta*. Head with waved brownish irrorations, but no lines as in *P. carneicosta*. There is a white subdorsal line, and the feet and legs are whitish, as is also the underside of the body. Length, 45 mm.

Food-plant.—Oak.

***Adipsophanes miscellus* Gr.**

The caterpillar transforms above the surface of the ground and spins an oval cocoon, mixed with grains of sand. The pupa is long and narrow in form and pale pitchy, almost chestnut brown and very shining. The abdominal segments are rugosely punctate on the anterior half. Spiracles dark pitchy. Cremasters composed of two spines, short but sharp. Length, 23 mm.; width, 6 mm. at the middle segments; anal segments, 4 mm.

***Perigea xanthioides* Guen.**

After Second Moul.—Dull flesh color, with a blackish tint and a very faint white dorsal line, which is joined to a triangular stripe on the head. There are also faint traces of subdorsal waved lines. Length, 10 mm.

After Third Moul.—The fourth and fifth segments are now swollen into a hump. Head small, black, with narrow white stripes in front, meeting on the crown of the head and then joining a dorsal white stripe, which is lost at the fourth segment, reappearing on the tenth and continued to the anal segment. The fourth and fifth segments are blackish in front, triangularly flesh colored behind, and there is a flesh-colored shade along the sides. The spiracles on the fourth and fifth segments are dull yellow and there are faint waved flesh-colored lines along the lateral region. Length, 22 mm.

After Fourth Moul.—Body now much lighter in color, having a flesh-colored tint, particularly at the posterior edge of the segments. The white dorsal shade line now continuous. The dark

shade on the anterior segments is produced triangularly behind. The tenth segment also raised into a hump. Length, 30 mm.

After Fifth Molt.—Now still paler, the pale stripes being pinkish, and the body covered with brown or blackish irrorations. Dorsal stripe clear white. Length, 42 mm.

Food-plants.—Iron-weed (*Vernonia noveboracensis*), Trumpet-weed (*Eupatorium purpureum*).

**Article IX.—SOME NOTES ON TRANSFORMATIONS
OF AUSTRALIAN LEPIDOPTERA, MADE BY THE
LATE HENRY EDWARDS, WITH NOTES AND
ADDITIONS.**

By WILLIAM BEUTENMÜLLER.

It is with melancholy pleasure that I present the following notes on some transformations of Lepidoptera, made by my deceased friend, Mr. Henry Edwards, during his last visit to Australia in 1889-'90. To these notes I have added the descriptions of the cocoons of *Discophlebia catocalina* Feld. and *Pelora oxleyi* McL., as was originally intended by Mr. Edwards, to complete the present paper, otherwise all the notes are his, except those in brackets. In the 'Victorian Naturalist,' Volume VII, 1890, p. 20, Mr. Edwards announced his intention of publishing a "Bibliographical List of Transformations of Australian Lepidoptera." This work was begun by Mr. Edwards shortly before his death, but unfortunately was not completed. I am now continuing Mr. Edwards's MSS. notes of this work, and hope to have the same ready for publication before long.

***Discophlebia catocalina* Feld.**

Cocoon.—Oblong oval, formed of fine fragments of earth and with a few grains of the excrements of the larva, neatly and firmly agglutinated. The interior is lined with a thin case of silk, and the imago escapes not at either of the extreme ends, but from the upper side, near the larger end of the cocoon. Length, 30 mm.; width, 17 mm.

Pupa.—Chestnut brown, smooth, rather short and swollen anteriorly.

One cocoon, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

***Darala acuta* Walk.**

Cocoon.—Composed of two layers, the inner one consisting of finely spun silk, rather loosely and irregularly woven; the outer

one of coarse silk, amongst which the larval hairs are thickly intermingled. These hairs are short, spiny, bright chestnut in color, and extremely poisonous when penetrating into the skin. They are difficult to extract and cause the flesh to smart and ache for several days. The silk of the outer cocoon is pale chestnut. Length, 60 mm.; width, 25 mm.

The cocoon is mostly found beneath the bark of *Eucalyptus*, and on the side of attachment only the inner cocoon is seen; through this the pupa is clearly visible. This is pale pitchy in color, rather short, rounded in front and wrinkled over its whole surface.

[One example, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

***Pelora oxleyi* McL.**

Cocoon.—Oval, flattened on the side of attachment and almost as broad as long, dark brown in color, with a grayish coating of glutinous matter; surface rather smooth. In appearance the cocoon resembles that of a *Limacodes*, in fact it is almost inseparable. The imago, when ready to make its escape, cuts out a circular piece at the end of the cocoon, as is also the case with other species of *Limacodidae*. Length, 15 mm.; width, 11 mm.

Five specimens, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

Mr. Edwards once told me that the larva feeds on *Eucalyptus robusta*, and gives out a very viscid humor when disturbed.

***Rhinogyne calligama* Feld.**

Cocoon.—Closely, but finely spun, with many extraneous materials mixed with the outer coat. If the larva is placed in a box to transform, part of the paper lining will be used, and if leaves or dry twigs be present, they also will be sparingly utilized. The color is dull pale brown. Length, 35 mm.; width, 18 mm.

Pupa.—Rounded in front, cylindrical, covered with tawny bristly hairs, very finely punctured and slightly shining over the whole surface. The color is pale pitchy. Length, 28 mm.

[One cocoon, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Oiketicus omnivorus Fereday.

Larva.—Head and three following segments sordid white, the head being thickly spotted with brown dots, irregularly placed. Second, third and fourth segments with a double rather broad line, of which the edges are irregular, narrowing at the base of the fourth segment, until the second lines are almost united. There are also two lateral lines, and between these another series of irregularly placed brown spots. The rest of the body is concealed within the case and is pitchy brown. The feet are sordid white at their base and pitchy at their tips. Mouth-parts pitchy. Length, 20 mm.

Clania tenuis Rosenst.

Larval Case.—Somewhat resembling in appearance that of *Entometa ignobilis* Walk., but much smaller, and composed of very much smaller twigs, all nearly equal in length and regularly united. The imago is difficult to raise, as indeed are all the *Psychidæ*. The cases are common on fences in the neighborhood of Melbourne, but the imago is very rarely seen. Length, 18 to 24 mm.

[Nine specimens, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Endoxyla cinerea.

Pupa.—General color pale chestnut brown, darkest posteriorly and over the head and thorax. The segments are slightly corrugated and have each a double row of raised roughened points, projected in the form of a ridge. Beneath the posterior of the abdominal legs is marked by a roughened ovate space. The anal segment is smooth, with a double furrow. The cremaster is rough, short, swollen, with a series of small points beneath. Head and thorax very glossy, wrinkled, the former rugosely punctate in front. Wing cases thin, the margins thickened, with the course of the veins indistinctly marked.

[Length of male, 75 mm.; width, 18 mm. Of female, 90 mm.; width, 24 mm. .

Nine specimens, Adelaide, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.

The species stands by this name in the Edwards Collection, though I do not know the authority. According to Mr. Edwards's notes, it is the species so common and destructive to *Eucalyptus* trees in the neighborhood of Adelaide. He has found as many as sixteen empty pupa cases sticking out of one tree. It is paler in color than *E. eucalypti*, and much larger.—W. B.]

Thyridopteryx herrichii Westw.

Pupa.—Pitchy black, fusiform, slightly swollen about the head parts, which are very finely punctate. Abdominal segments shining anteriorly, but roughened and dull on the posterior half. Cremaster very short, bifurcate, bent under; spiracles large, wart-like, very rough. Length, 12 mm.

[One specimen, Victoria, Australia, Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Antheræa helena Scott.

Cocoon.—Very closely and thickly spun, rather large and more elongate in form than that of *A. eucalypti*. Color bronze brown, very glossy and with a large quantity of glutinous matter mixed with the outer coat. Leaves and twigs are generally associated with the cocoon. It is difficult to define the difference in words, but an experienced eye will soon detect the difference between this and the cocoon of *A. eucalypti*. Length, 45 mm.; width, 28 mm.

[One specimen, Sidney, N. S. W., Coll. Hy. Edwards, Am. Mus. Nat. Hist.—W. B.]

Antheræa janetta White.

Egg.—Oval, very slightly flattened on the upper side, rather glossy, cream white, without markings. They are 2 mm. in length and a little more than half as broad. About 150 eggs are deposited by the parent.

Antheræa eucalypti Scott.

Egg.—Larger than the preceding species, though exactly like it in form, color dirty white, rather than cream color, the surface under a high power, showing traces of very fine-waved sculptures. The eggs are always laid on the edges of a leaf.

Article X.—NOTES ON THE TRANSFORMATIONS OF SOME SPECIES OF LEPIDOPTERA.

By HENRY EDWARDS and S. LOWELL ELLIOT.

Edited, with additions, by WILLIAM BEUTENMÜLLER.

The following notes were made by the late Messrs. Henry Edwards and S. Lowell Elliot on the earlier stages of some species of Butterflies and Moths in the collection of the latter.

The Elliot Collection of Insects was generously donated to the Museum by his widow, while the notes passed into the hands of Mr. Edwards, who kindly gave me permission, shortly before his death, to publish them, as a continuation of the paper published by him, in conjunction with Mr. Elliot, in 'Papilio,' Vol. III, pp. 125-136. To the notes that follow I have added the description of the larva and pupa of *Doryodes acutaria*, and the notes in brackets.

Papilio cresphontes Cram.

Egg.—Ovate, attached by a rather flattened base to the upper-side of the leaf. It is covered with an orange mealy substance, which, after exclusion of the caterpillar, renders the egg slightly obscure.

Young Larva.—Olive green, with the third, fourth, fifth, eighth and ninth segments somewhat darker, with a number of tubercles on each. Length, 3 mm.

After First Moul.—Head in front, with a triangular white mark. Body darker than in the previous stage, with paler portions more in contrast. The piliferous tubercles are six to each segment, those of the second segment being the largest. Length, 8 mm.

After Second Moul.—The body color is now blackish olive, and the paler portions on the fourth and terminal segments dull pink, with an olive stain, the pink shade reaching to and enclosing the spiracles. The tubercles are larger and very shining. Length, 15 mm.

***Lycæna comyntas* Godt.**

Young Larva.—Dull green, the dorsal region elevated, covered with short soft hairs; a faint dorsal line of dull olive green, composed of two oblique stripes meeting in the centre, and a lateral stripe of the same shade similarly composed. Mouth-parts and head pale testaceous; legs, concolorous.

After Third Moulting.—The body in this stage is purplish brown, with a well-defined dorsal line of darker shade, and two oblique narrow paler stripes on each segment. Lateral line below the spiracles, white; underside, including legs, dull greenish.

Full-grown.—The colors are brighter, and the oblique whitish stripes form a triangular blotch on each segment, joining the dorsal line and becoming a portion of it. They are reddish lilac, and are edged narrowly with white. The three terminal segments have these marks very faintly indicated. The lateral line is also dull lilac.

[*Food-plant.*—*Lespedeza*, feeding amongst the bunches of the flowers, and always surrounded by large quantities of ants.]

***Datana major* G. & R.**

After Second Moulting.—Ground color bright reddish brown. Head and first segment wholly reddish brown, as is also the anal segment. There is a series of eight very bright lemon-yellow stripes—the space on the dorsal region between the stripes being the widest, as is usual in the genus. Underside wholly reddish brown.

After Third Moulting.—Head greatly increased in size. First segment reddish brown only on the dorsal region. Stripes still more distinct and very vivid yellow. Underside reddish brown with a yellow ventral stripe.

Full-grown Larva.—Ground color of body jet black. Head and middle of first segment bright chestnut red. Each segment bears a series of eight broken stripes of bright canary yellow, the patches being composed of oblong pieces, except those above the base of the legs, where they are quite irregular in shape.

The feet and legs are bright chestnut red. Segments sparsely covered with sordid white hairs; anal claspers bright chestnut red. The stripes and patches in some broods are white instead of yellow. Length, 60 mm.

Food-plant.—*Andromeda ligustrina*.

[I found the larva feeding on Witch-Hazel (*Hamamelis virginica*) at West Woodstock, Conn., last September. This is a new food-plant for the species.]

Acronycta dactylina Gr.

Full-grown Larva.—Body dull black. The hairs of the dorsal region are tawny brown, those of the lateral region clear white, the caterpillar having the appearance (when moving, and the segments being devided) of the skin of a tiger, the colors being precisely the same. The head is jet black, shining. The fifth, seventh and twelfth segments bear a single median pencil of black hairs. Spiracles, cream white; underside and legs wholly black. Length, 50 mm.

[*Food-plants.*—Willow (*Salix*); White Birch (*Betula alba*).]

Hadena turbulenta Hub.

The larva of this species, before undergoing the change to pupa, collects small masses of sand and of the particles forms a cocoon, which is ovate and regular in outline. The pupa is thickened about the head parts and wing-cases, and very much roughened, while the abdominal region is smooth and shining. Length, 21 mm.

[The larva feeds on Catbriar (*Smilax rotundifolia*) in large swarms. It was described by me in the 'Canadian Entomologist,' Vol. XX, p 136.]

Mamestra legitima Gr.

After Second Moul.—Very pale apple green, with a broad dorsal and two narrow lateral white stripes, the spaces between filled with white specks. The head and second segment are free from white and are wholly pale greenish. Head rather small with the mouth-parts slightly pitchy. Length, 15 mm.

[*Full-grown Larva*.—In this stage the larva has become slightly yellowish green, with the dorsal line strongly marked, the lateral less so and of a bright yellowish tint. The speckles have become very decidedly yellow, with the spots fewer and yellower. The lateral line is broader towards the anal segment. Length, 30 mm.

Food-plant.—Wild Cherry (*Prunus serotina*).]

[*Doryodes acutaria* H. S.

Full-grown Larva.—Body pale ashen brown, with a number of very narrow, indistinct longitudinal stripes of almost the same color as the body, a broad indistinct stripe on the dorsum, and along the subdorsal region and sides a pale ochreous stripe, followed by one a little deeper in color. Underside paler than above, and also with a number of indistinct stripes. Head of the same color as the body with a number of stripes. On the eighth and ninth segments a pair of abdominal legs, of the same color as the body, as are the anal and thoracic legs. Length, 34 mm.

The larva is a semi-looper, and when at rest mimics a blade of withered grass. It lives on species of grass found in salt marshes, and spins an elongated cocoon between pieces of grass and stems. Length, 30 mm.; width, 5 mm.

The pupa is reddish brown, smooth, and covered with a bluish white farinaceous matter. Sides nearly parallel, and the posterior extremity of the last segment bluntly rounded. Length, 15 mm.; width, 3 mm.]

Chamyris cerintha Tr.

Full-grown Larva.—Head light olive gray, with two oblique purplish-brown stripes. Dorsal region purplish brown, with two subdorsal stripes of pale pinkish white. Underside and extreme sides dull green. Anal segment and claspers very long. Each segment on the dorsum has four small concolor tubercles, and there are a number of long hairs over the whole surface. Feet and abdominal legs pinkish brown. The tubercles on the last segment are larger than the others. Length, 1.10 mm.

Changed to pupa August 23, on ground, between leaves drawn together with a few silken threads. The pupa is pale ochreous, and rather long.

Food-plant.—*Cratægus*.

Ennomos alniaria Linn.

The larva spins a thin but firm ovate elongated whitish web on the underside of a leaf. The web is open at both ends so as to allow the insect easy escape. The pupa is pinkish white without any markings, and is suspended inside the web. It is roughened on all the segments, but the spaces between are semi-transparent and yellowish. The pupa is also covered with a mealy substance. Length, 35 mm. Length of web, 35 mm.

Chærodes clemitaria A. & S.

Full-grown Larva.—Head large, produced in front. Third segment very much swollen on the crown, but forming only one tubercle and looking like a portion of the head, until examined with a lens. The tubercle is not divided as in *Eubyja cognataria* Guen. Body purplish brown, marbled with a paler shade, each segment with eight slightly raised pale points, two in centre of segment, two nearer the posterior edge, and two near the spiracles on each side. On the seventh segment are two large tubercles raised much above the surface, shaded with chestnut brown, and two swollen ones on the twelfth segment of the same color. The spiracles are dull orange, edged with black, that of the second segment appearing in front as if upon a portion of the head. Underside of body marked like the upper, the lateral fold, below the spiracles, being in twisted corrugations. Length, 55 mm.

[*Food-plant.*—Dogwood (*Cornus florida*).]

Eccopsis inornatana Clem.

Full-grown Larva.—Pale vivid apple green, with yellowish hairs. Head dull jet black, also the second segment, with a very few hairs. Feet, legs and underside wholly apple green. Length, 20 mm.

[*Food-plant.*—Wild Cherry (*Prunus serotina*).]

***Cacæcia rosana* Linn.**

Full-grown Larva.—Dull whitish green. Head and posterior half of the second segment dull black. There are also two blackish spots on the sides of the second segment. The feet are pitchy black, and the abdominal legs the same color as the body. Length, 13 mm.

***Cacæcia parallela* Robs.**

Full-grow Larva.—Dull olive green. Head dull orange; second segment paler yellow, with two black dots in front on a narrow white line, and a black semi-circular band passing along the base of the segment and ending at the exterior margin. The remaining segments have each eight white tubercular spots from which spring whitish hairs. Feet blackish. Abdominal legs concolorous with the body. Length, 20 mm.

Food-plants.—Willow, Aster.

Article XI.—FOSSIL MAMMALS OF THE WAHSATCH AND WIND RIVER BEDS. COLLECTION OF 1891.

By HENRY FAIRFIELD OSBORN and J. L. WORTMAN.

With One Plate and Eighteen Figures in Text.

INTRODUCTION.

This paper is mainly given to a description of a collection made by Dr. Wortman in the Wahsatch (Big Horn) and lower Bridger (Wind River) beds during the summer of 1891. It includes the following special articles, each writer being responsible only for his own :

I.—Homologies and Nomenclature of the Mammalian Molar Cusps (<i>H. F. O.</i>).....p.	84
II.—The Classification of the Perissodactyla (<i>H. F. O.</i>).....p.	90
III.—The Ancestry of the Felidæ (<i>J. L. W.</i>).....p.	94
IV.—Taxonomy and Morphology of the Primates, Creodonts and Ungulates; 1, Wahsatch; 2, Wind River (<i>H. F. O.</i>).....p.	101
V.—Geological and Geographical sketch of the Big Horn Basin (<i>J. L. W.</i>).....p.	135
VI.—Narrative of the Expedition of 1891 (<i>J. L. W.</i>).....p.	144

Many new facts of great interest are brought out by the material in this collection, although Professor Cope has worked for years upon the Wahsatch fauna, with the assistance of Dr. Wortman in the field.

1. The lower jaw of *Anaptomorphus homunculus* is found to contain three premolars, instead of two, as in the type species *A. æmulus* (p. 102).

2. The genus *Palæonictis*, hitherto found only in the Suessonian of France is also found in the American Wahsatch. The complete dentition and the facial region of the skull show that it is an extremely modified type, with only a single fully functional upper molar. It represents a family, the Palæonictidæ, including *Ambloctonus* (p. 106), and perhaps *Patriofelis* (p. 97), and is more like the Cats than any Creodont which has yet been found (pp. 95, 103).

3. Additional remains of *Oxyæna* show that the manus of this Creodont had a separate scapho-lunar and an os-centrale; the lumbar vertebræ have involuted zygapophyses; the pes is not cleft as Cope has described it. The incisors were $\frac{3}{8}$ (p. 109).

4. Among the Mesonychidæ is a small new form related to *Dissacus* of the Puerco, and a very large new species of *Pachyæna*, by far the largest Creodont which has yet been found in the Wahsatch (p. 112).

5. The genus *Anacodon*, which has been doubtfully placed by Cope among the Condylarthra, is found to belong to the group of Creodonts with tubercular molars near *Arctocyon*. The upper and lower molar cusps are obtuse and covered with a great number of accessory tubercles; the premolars are reduced in number and pointed (p. 115).

6. Complete limbs of *Coryphodon* show that the fore foot was digitigrade, as in the Elephant, while the hind foot was fully plantigrade, the whole plantar surface resting upon the ground as in the most primitive Ungulates (pp. 120-122).

7. The complete dentition of *Systemodon*, the earliest form of Tapir, is described (p. 124).

8. The complete limbs of *Heptodon* (Wind River), show that this animal belongs, with *Helaletes* of the Bridger, to a side line of small Perissodactyls with greatly reduced lateral toes. This family of Helaletidæ extended from the lower Eocene into the Miocene; it is not ancestral to the Tapirs as Marsh supposed, nor is it (*Heptodon*) ancestral to the *Hyrachyus* series as Cope has suggested. The tooth structure is intermediate between the two. The foot structure is highly modified and aberrant both in the marked shortening of the lateral digits and in the long narrow terminal phalanges. *Heptodon calciculus* was a small, light limbed animal, somewhat of the dimensions of the Peccary (p. 129).

9. Many additional characters of *Palæosyops borealis*, the earliest known representative of this important Bridger genus, are noted (p. 132).

We pass by a large number of forms in the collection in which there is nothing to be added to the observations of Cope.

DISTRIBUTION TABLE.

Number of individual Specimens of each Genus.	Preliminary Reference of Genera and Species.	WASATCH.			BRIDGER. (Wind River.)
		Gray Bull.	Clark's Fork Basin.	Buffalo Basin.	Wind River Basin.
	<i>Primates.</i>				
40	<i>Hyopsodus</i>	X	....	X	
16	<i>Pelycodus</i>	X	....	X	
2	<i>Cynodontomys</i>	X			
4	<i>Anaptomorphus homunculus</i>	X	..	X	
	<i>Rodentia.</i>				
5	<i>Plesiarctomys</i>	X	....	X	
	<i>Creodonta.</i>				
1	<i>Palæonictis occidentalis</i>	X			
8	<i>Oxyæna lupina</i>	X	....	X	
	“ <i>forcipata</i>	X			
8	<i>Stypolophus</i> (3 species)	X	....	X	
5	<i>Miacis canavus</i>	X	....	X	
	“ <i>brevirostris</i> .....	....	....	....	X
	“ <i>edax</i>	X	....	X	
6	<i>Didymictis leptomytus</i> .....	....	....	X	
	“ <i>dawkinsianus</i>	X			
	“ <i>curtidens</i>	X			
3	<i>Anacodon ursidens</i> .....	....	....	X	
8	<i>Pachyæna ossifraga</i>	X	....	X	
	“ <i>gigantea</i>	X			
	<i>Tillodontia.</i>				
6	<i>Esthonyx</i>	X	....	X	
	<i>Taniodontia.</i>				
1	<i>Calamodon simplex</i>				
	<i>Amblypoda.</i>				
31	<i>Coryphodon radians</i>	X	....	X	? X
	“ <i>elephantopus</i>	X	....	X	
	“ <i>obliquus</i>	X			
	“ <i>anax</i>	X			
	<i>Condylarthra.</i>				
16	<i>Phenacodus primævus</i>	X	X		
1	“ <i>wortmani</i>				X
	<i>Perissodactyla.</i>				
69	<i>Hyracotherium</i>	X	X	X	X
50	<i>Systemodon tapirinus</i>	X	....	X	
	“ <i>semihians</i>	X			
2	<i>Heptodon calciculus</i> .....	....	....	....	X
1	<i>Palæosyops borealis</i> .....	....	....	....	X
	<i>Artiodactyla.</i>				
3	<i>Pantolestes</i>	X			

In the field great care was taken to observe and record the localities, and especially to note whether the fossils were from the lower, middle, or upper portions of the great Wahsatch beds of the Big Horn Basin, which are variously estimated at 2000 to 3000 feet in thickness. Of course this depth of rock represents a very long period of time in which the various species underwent considerable modification. We have therefore published in full Dr. Wortman's field notes upon the geology of the Big Horn and Wind River Basins, as well as geographical details, which will be of great service to collectors in the future (pp. 135-144). We give (p. 83) a preliminary conspectus of the distribution of the species; this cannot be fully made out until all the species are determined by a comparison with Cope's types.

Before taking up the systematic description of the collection, we offer three introductory sections, treating of the structure of the molar teeth, the classification of the Perissodactyla, and the origin of the Felidæ.

I.—HOMOLOGIES AND NOMENCLATURE OF THE MAMMALIAN MOLAR CUSPS.

In October, 1888, a table of nomenclature for the cusps of the molar teeth of mammalia was published in the 'American Naturalist.' The terms were carefully chosen with reference to the gradual rise of these cusps from the single cone of the reptilian type, through the tritubercular to the sextitubercular stages.¹ They have since been wholly or in part adopted by Cope, Scott, Lydekker, Schlosser,² Flower, and lately by Rüttimeyer.³ The tritubercular stem form has been recognized by Döderlein and Fleischmann, but these authors have employed various Greek symbols for the cusps. The latter has opposed the adoption of similar terms for the main cusps of the upper and lower molars, upon the ground that Cope and myself have mistaken the homolo-

¹ Osborn, *The Nomenclature of the Mammalian Molar Cusps*, op. cit., p. 927.

² See also *Evolution of Mammalian Molars to and from the Tritubercular Type*, *Am. Nat.*, December, 1888.

³ Schlosser, *Die Differenzierung des Säugethiergebisses*, *Biologisches Centralblatt*, Juni, 1890.

⁴ *Die Eocene Säugethier-Welt von Egerkingen*, Zurich, 1891.

gies; this objection would be fatal to a uniform system of nomenclature for the upper and lower cusps if it could be sustained, but a comprehensive survey of the Mesozoic trituberculates, especially of the Amblotheriidæ and Spalacotheriidæ, leaves no doubt that *the antero-external cusp in the lower molars and the antero-internal cusp in the upper molars of the mammalia are homologous with the reptilian cone and with each other*; these cusps are invariably the most prominent, and are always styliform in primitive types; they always form the apices of the primitive crown; they persist in almost all mammals, while one or all of the later cusps may disappear.

This cardinal point established, it will be a great gain for palæontology and comparative odontology when the further truth is recognized that *the possibilities of modification of type in the molars are limited*, that essentially similar types of teeth are evolved independently over and over again, and that in course of what Schlosser has well termed 'modernization' we find such diverse orders as Primates, Ungulates, Insectivores, Marsupials, Rodents, all exhibiting the same laws of dental modification, and the same or similar 'secondary' cusps, crests and peripheral styles.

Excepting in the Cetacea and Edentata, these modifications centre around the simple tritubercular crown, which seems to possess unlimited capacity of adaptation by the development of some parts and degeneration of others, by changes of form and position, and by the addition of secondary cusps.

The first step is to distinguish and separate clearly the primary and secondary regions of the primitive crown, for originally they have absolutely different functions; the part first developed in both upper and lower molars is the anterior primitive triangle or *trigon*, which has a cutting or piercing function; out of its three cones all 'secodont' types of molars are evolved. The part next developed is the *talon*, or heel, which has a crushing or grinding function, and therefore plays a chief rôle in all 'bunodont' types. The first diagram exhibits the relations of these two portions of the crown in the upper and lower molars, and the six primary and secondary cusps which typically develop upon each (Fig. 1).

We will not enter here into the well-understood transformation of this tuberculo-sectorial type into the sextitubercular bunodont

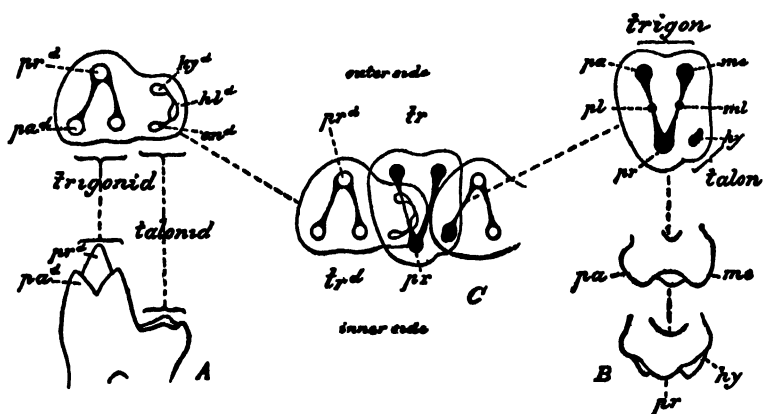


Fig 1 Diagram of the Tuberculo-Sectorial Stage of Mammalian Molars A, The lower molar, crown and internal view B, The upper molar, crown, internal and external views C, Opposition of upper and lower molars

type, seen typically in the upper and lower molars of the Puerco *Protoponia*, which is the least specialized ancestral bunodont form that has been discovered. We may lay emphasis upon the fact that the *parent form of ungulate molar has six tubercles* both above and below instead of six above and four below as formerly supposed.

It is important to remember, as an exception to the law of sextitubercular origin, that all the Amblypoda and all the Periptychidæ¹

(among the Condylarthra) developed their upper molars upon the trigonal basis, out of the three tubercles of the tritubercular crown, and without becoming sextitubercular, that is, without the addition of the hypocone or talon.

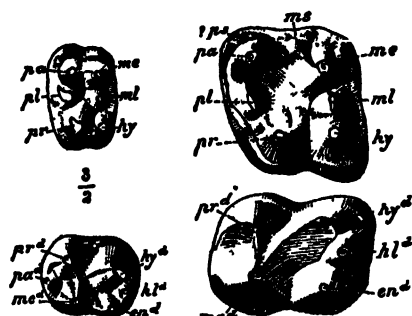


Fig 2 The Primary Cusps of an Ungulate (Perissodactyl-Artiodactyl) Molar, *Protoponia puericensis*, and of the Condylarth, *Phenacodus primaeus* (For abbreviations, see table, page 91)

Now how shall we study the molar teeth of the early Ungulates, especially of the apparently

¹ There are considerable grounds for removing the Periptychidæ from the Condylarthra to the Amblypoda.—O.

similar primitive forms of Perissodactyls, which are so difficult to distinguish? The following steps must be taken:

First.—Locate each of the six primary and secondary cusps, as far as they are present.

Second.—Note the *form* of each, whether rounded (bunoid), crested (lophoid), or crescentic (selenoid).

Third.—Note the *position* of each upon the crown with relation to the other cusps.

Fourth.—Note the *relative size* or development of each.

Fifth.—Note the relative development of the *cingulum*, in different parts of the contour.

Sixth.—Note the presence of one or more *peripheral secondary cusps*, which develop from the cingulum, or external borders of the crown.

Finally.—If *crests* are formed or forming, note the points at which the transverse crests unite with the external cusps (paracone and metacone, parastyle and mesostyle).

These differential features, it will be observed, follow the progressive order of evolution in the molar crowns, for in 'modernization' we see, first, a *degeneration* of one or more of the primary cusps, then a *remodelling* of the form of each cusp which may affect the twelve upper and lower cusps very differently: for example, in such an ancient type as *Meniscotherium* we find one bunoid, two lophoid, and three selenoid cusps in each of the upper molars. Third, the cusps begin to shift their positions upon the crown. Fourth, they begin to develop unequally. Fifth, the cingulum, which is primitively a complete peripheral band, begins to disappear at certain points. Sixth, one or more peripheral cusps grow up from the cingulum or upon the sides of the main cusps. Finally, as the crests develop, the unequal development of the cusps causes the transverse crests to unite at different points with the external crest.

We find that if such analysis be applied to the elements of the molar teeth we derive an absolutely infallible means of distin-

guishing different lines of descent, for the above are the main features of divergent evolution.

The primitive horse, tapir, rhinoceros and titanotherium all stand apart and cannot be confused; each have their clear differentia. To check the possibility of being misled by *parallelism* in molar form, we should next observe the dental series as a whole, the proportionate development of different members of the series—the *metatrophism*; this often furnishes the final proof or disproof of relationship, so far at least as can be derived from the dentition alone.

The above method of analysis is the outgrowth of an extremely careful study and comparison of all the early Condylarthra and Perissodactyla, and it has been found necessary to exercise the closest scrutiny to distinguish these early stages of divergence.

Now to turn to the subject of nomenclature, the system of terms was originally based upon the actual homologies of the primary elements of the trigon and trigonid, but in extending it to the other parts of the crown and to the secondary cusps it was found that we must apply similar terms to some of the later elements in the upper and lower teeth, which are merely analogous to each other (performing a similar function, occupying a similar position, and developing at about the same period), otherwise the terms soon multiply so as to become a burden rather than a convenience.

As far as possible, therefore, the same prefixes are retained for the secondary parts of the molars as for the primary; thus the anterior transverse crest of the upper molars is called the *protoloph*, as it is invariably developed by the union of the protocone, protoconule and paracone or parastyle, never from the metacone. The anterior transverse crest of the lower molars is termed the *metalophid* because it is always developed from the metaconid or metastyle, and protoconid, never from the paraconid; the posterior transverse crest of the lower molars is termed the *hypolophid*, because it is mainly formed by the hypoconid and entoconid, never from the metaconid or paraconid. The external crest of the upper molars is composed of so many cusps that it requires a distinct prefix, but is readily remembered as the *ectoloph*. So with the peripheral cusps, one or more of which are developed in

all Ungulates, and are especially numerous in molars of the Equidæ; to these the terminal *-style* is applied in lieu of the English term 'pillar' proposed by Huxley—we can readily locate

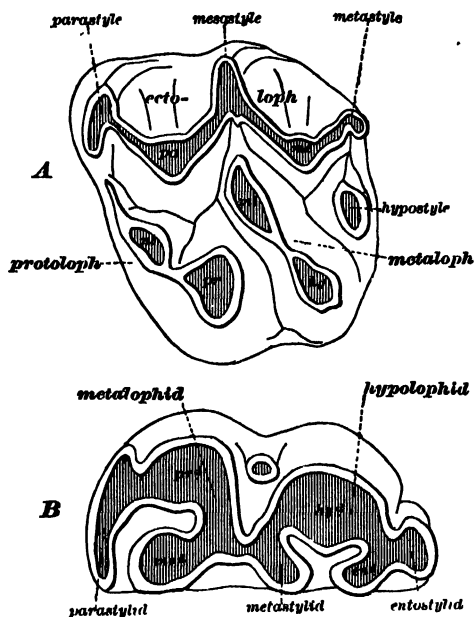


Fig. 3. The Secondary Cusps of an Ungulate Molar. A, *Anchitherium*, upper. B, *Merychippus*, lower. The Primary Cusps are indicated by abbreviations.

the *parastyle*, as the antero-external buttress which is developed near the paracone, the *mesostyle* as developed on the outer wall between the paracone and metacone. Similarly, in the lower molars, we find in several lines of Ungulates, but again most conspicuously in the Equidæ, that the metaconid and entoconid are reinforced by little cusps which grow up behind them (*a, a* and *b, b*, Rüttimeyer); these may be termed respectively the *metastylid* and *entostylid*, while the pillar arising secondarily in

the primitive position of the paraconid may be termed the *parastylid*.

The principles upon which this terminology is based are therefore very simple.

1. The termination *-cone* is given to the main primary or central cusps, and *-conule* to all intermediate cusps.
2. The termination *-style* is proposed for the peripheral cusps arising mainly from the cingulum.
3. The termination- *-loph* is applied to the crests.
4. The seven prefixes are based upon the succession and position of the elements in the primitive evolution of the crown, viz. :

proto-, para-, meta-, hypo-, ento-, ecto-, meso-. The prefixes are first applied to the cones; then to the styles, according to their proximity to the cones; then to the crests, according to the cones which mainly compose them.

5. Homologous and analogous elements in the upper and lower jaws are given similar terms, but distinguished arbitrarily by the terminal *-id*.

Upon the opposite page are given the terms formerly employed by French, German and English authors for the teeth of the Ungulates before their common tritubercular origin had been discovered by Cope. In his 'Enchainements du Monde Animal' Professor Gaudry, as far back as 1878, worked out most clearly the homologies of the molar elements in the Ungulates from the sextitubercular-quadrutubercular stage onwards; the valuable earlier studies of Rütimeyer¹ are well known. But now that the ungulate molar has been found to converge to the unguiculate molar type, and both are found to contain the same elements, and to spring from the same mesozoic source, it is important to unify our methods of description by adopting a set of terms which refer back to the primitive form and position in place of those which were based upon the comparatively modern form and position.

II.—THE CLASSIFICATION OF THE PERISSODACTYLA.

In this paper a departure from the current system of classification of the fossil Ungulates is adopted—the early members of each of the great families of Perissodactyla are placed in sub-families under the most recent family names, Equidæ, Rhinocerotidæ, Titanotheriidæ, etc.

The main desiderata of classification are: first, clearness in the expression of phyletic relationships; and second, convenience. Neither is attained when we place the well-determined ancestors of existing or of recently extinct families in separate families founded upon the similar transition characters of ancestral types. We have elsewhere² protested against the principles of family

¹ *Beiträge zur Kenntnis der fossilen Pferde*, Berlin, 1863.

² See Osborn, *The Mammalia of the Uinta Formation*, pp. 550, 536 (footnotes).

TERMINOLOGY OF THE PRIMARY AND SECONDARY ELEMENTS OF MAMMALIAN MOLAR TEETH.

	GAUDRY, FILHOL, French authors.	RÜTIMEYER, KOWALEVSEY, German authors.	HUXLEY, FLOWER, LYDEKKER, English and American authors.	Terms based upon primitive homologies.	Abb.
PRIMARY CUSPS. <i>Upper Molars</i>	denticule interne du premier lobe.	innenpfleiler des vorjochs. (<i>inneren Hauptpfleiler</i> .)	antero-internal, anterior pillar.	protocone	pr
	" " externe	" "	antero-external, anterior crescent.	paracone	pa
	" " médian premier	" "	postero- " posterior	metacone	me
	" " " second	" "	antero-intermediate tubercle	protoconule	pl
<i>Lower Molars</i>	" " interne	innenpfleiler des nachjochs. (<i>inneren Hauptpfleiler</i> .)	postero- " "	metaconule	ml
	" " externe du premier	" "	postero-internal, posterior pillar.	hypocone	hy
	" " " (interne antérieure)	" "	antero-external cusp.	protoconid	pr ^d
	" " du premier	" "	" internal, fifth cusp.	paraconid	pa ^d
CRESTS. <i>Upper Molars</i>	" " externe du second	" "	postero-external " "	metaconid	me ^d
	" " interne	" "	" internal " "	hypoconid	hy ^d
	" " médian	" "	postero-internal, third lobe.	entoconid	en ^d
	" " crête externe.	" "	postero-external, third lobe.	hypoconulid	hl ^d
<i>Lower Molars</i>	premier lobe, crête antérieure.	aussewand	external crest, dorsum.	ectoloph	
	second lobe, crête postérieure	vorjoch.	anterior crest, or collis.	protoloph	
	premier lobe, crête antérieure	nachjoch.	posterior " "	metaloph	
	second lobe, crête postérieure	vorjoch.	anterior crest.	metalophid	
PERIPHERAL CUSPS. <i>Upper Molars</i>	" " "	nachjoch.	posterior " "	hypolophid	
	" " "	schlussjoch.	third lobe.	hypoconulid	
	" " "	pericones, Randgriffeln.	anterior buttress, ridge, costa.	parastyle	ps
	" " "	" "	median " "	mesostyle	ms
<i>Lower Molars</i>	" " "	" "	posterior " "	metastyle	mts
	" " "	" "	" prominence, pillar.	hypostyle	hs
	" " "	" "	reduplication of metaconid.	metastylid	ms ^d
	" " "	" "	" " entoconid	entostylid	es ^d

PRIMARY AND SECONDARY DIVISIONS OF CROWN.

Primitive triangle, { *Upper Molars*. Trigon (protocone, paracone, metacone). Secondary talon, heel, { *Upper Molars*. Talon (hypocone).
 Anterior portion of { *Lower* " " Talonid (hypoconid, entoconid, hypoconulid).
 crown.

division adopted by Cope and Lydekker, especially against the meaningless term *Lophiodontidæ*. Why not place an ancestral horse among the Equidæ, instead of terming it a 'lophiodont,' especially when we are at present ignorant what the Lophiodontidæ were? Formerly there may have been some ground for the use of the latter family in a vague comprehensive sense to embrace Perissodactyls in a common stage of premolar evolution (*i. e.*, premolars simpler than molars), but this ground has been wholly removed by the discovery that even in the Wahsatch period the horses, tapirs, titanotheres, hyracodonts, rhinoceroses and other series were clearly separated from each other, either by well-marked structural characters in the teeth and feet or by well-defined developmental tendencies. If we embrace primitive horses, tapirs and rhinoceroses in the Lophiodontidæ on the ground that the premolars in these animals are unlike the molars, we practically raise this *family* to the rank of an *order*, and, moreover, find it impossible to define it, for we thus confuse a merely similar stage of evolution with a similarity of descent.

Schlosser, with whose ideas about classification we thoroughly agree, has taken the other extreme, and placed all the extinct forms under the recent families;¹ this is a far clearer method, but it is even preferable to group earlier and collateral forms under subfamily names.

By such an arrangement of the Perissodactyla we pass from one extreme to the other in the types of transformation of the molars. We give chief weight to tooth structure, as for example in separating the *Heleletes* from the *Hyrachyus* series, and secondly to foot structure, as for example in the doubtful separation of the *Palaplotherium* (monodactyl tendency) from the *Palæotherium* (typical tridactyl) series. The position of the Amynodontidæ² will remain somewhat uncertain until we ascertain the foot structure; the tooth structure is intermediate between that of *Hyrachyus* and *Rhinocerus*. The position of the Lophiodontidæ is also uncertain; the Lophiodons are not, as generally supposed, related to the Tapirs, and until we ascertain the skull and foot structure

¹ Beiträge zur Stammesgeschichte der Hufthiere Morph. Jahrbuch, Bd. XII.

² This family was defined by Osborn, *Mammalia of the Uinta Formation*, p. 507.

Molar Type.	Family	Eocene, Miocene, or Pliocene.	Subfamily.	Premolar Metamorphosis.	Brachyodont or Hypsodont.	No of Digits.	Earliest Genus.	Latest Genus.
Buno-Selenodont . . .	I. Titanotheriidae . .	E. M.	Palaeosyopinae Titanotheriinae . . .	p. < m. p. = m.	Br. "	4-3 4-3	Palaeosyps Titanotherium . . .	Diplacodon. o
Lopho-Selenodont . . (Equine.)	II. Equidae	E.	Hyracotheriinae . . .	p. < m.	"	4-3	Hyracotherium	Ephippus.
		M.	Anchitheriinae . . .	p. = m.	"	3-3	Meshippus . . .	Merychippus.
Sub-Lophodont (Tapirine.)	III. Palaeotheriidae . .	P.	Equinae	p. = m.	Hy.	1-1	Prohippus . . .	Equus.
		E.	Palaplotheriinae . .	p. < m.	Br.	? 3-3	Propalaeotherium	Palaplotherium.
Transitional	IV. Tapiridae	E.	Palaeotheriinae . . .	p. = m.	"	3-3	Palaeotherium . . .	o
		E.	Systemodontinae . .	p. < m.	"	? 4-3	Systemodon	Isectolophus.
Lophodont (Rhinocerotine.)	V. Helaeidae	M.	Tapirinae	p. = m.	"	4-3	Protapirus	Tapirus.
		E.	Helaeiinae	p. < m.	"	4-3	Heptodon	Helaletes.
Lophodont (Rhinocerotine.)	VI. Lophiodontidae . .	E.	Lophiodontinae . . .	p. < m.	"	? 3-3	x	Lophiodon.
		E.	Hyrachyinae	p. < m.	"	4-3	x	Hyrachyus.
Lophodont (Rhinocerotine.)	VII. Hyracodontidae . .	M.	Hyracodontinae . . .	p. = m.	"	3-3	Hyracodon	o
		E.	Triplopodinae . . .	p. < m.	"	3-3	x	Triplopus.
Lophodont (Rhinocerotine.)	VIII. Amynodontidae . .	E.	Amynodontinae . . .	p. < m.	"	?	x	Amynodon.
		M.	Amynodontinae . . .	p. = m.	"	.....	Metamynodon . . .	o
Lophodont (Rhinocerotine.)	IX. Rhinocerotidae . .	M.	Aceratheriinae . . .	p. = m.	"	4-3	Aceratherium . . .	Aphelops.
		M.	Diceratheriinae . . .	.....	"	.....	Diceratherium . . .	o
Lophodont (Rhinocerotine.)	IX. Rhinocerotidae . .	P.	Rhinocerotinae . . .	p. = m.	"	3-3	x	Rhinocerus.
		P.	Elasmotheriinae . . .	p. = m.	Hy.	.....	x	Elasmotherium.

p. < m., premolars simple. p. = m., premolars molariform. Br., brachyodont. Hy., Hypsodont. x, Unknown members of series. o, Extinction of subfamily.

they remain problematical; the nearest relatives are the Helalætidæ.

The sub-families of Rhinocerotidæ are equivalent to what Lydekker has called "Aceratherine Group," "Diceratherine Group," etc. As several of these groups contain more than one genus, it appears convenient to raise them to the rank of sub-families. It is evident that the Systemodontinæ and Tapirinæ are very similar in tooth structure, and that their relationship will turn upon the structure of the feet.

III.—THE ANCESTRY OF THE FELIDÆ.

THE MIOCENE CATS.—So far there appears to be entire unanimity of opinion in favor of the proposition that the Miocene Nimravidæ stand in direct ancestral relation to the true cats, and while they exhibit a number of primitive characters yet, even at the beginning of the Miocene epoch, they had become sufficiently specialized to present many of the more important characters which now distinguish the modern Felidæ.

There can be little doubt but that the Nimravidæ present many resemblances to the Viverridæ, chiefly through the living genus *Cryptoprocta*, which Mivart refers to this latter family. These resemblances have influenced Scott to believe that the two families have had a common ancestry.¹ Whether this proposition is true or not future discovery must decide.

Some of the more striking characters in which the Nimravidæ resemble the cats most, are seen in the short muzzle in comparison with the skull, the wide zygomata, the divergence of the tooth lines posteriorly, together with the reduction in the molar and premolar dentition. Other characters of importance are the straight transverse line in which the lower incisors are placed, together with those derived from the lower jaw.

The principal characters in which they differ from the true cats are to be found in the foramina at the base of the skull, the possession generally of a second lower molar, the greater size and less internal position of the single upper molar, the presence of a distinct talon, and the frequent appearance of an internal

tubercle upon the lower sectorial. The superior sectorial is, moreover, less perfect in generally lacking the third lobe or anterior cutting blade, while the premolar formula as a rule is less reduced. To these must be added other characters derived from the skeleton (Fig. 5, *B*).

It is to be borne in mind that these generalized Nimravine forms made their appearance in the oldest Miocene deposits of this country and probably at an earlier date in Europe, if we consider the Phosphorites of France to belong to the upper Eocene, as is done by some palæontologists, so that their ancestry must be sought for in formations older than this horizon. The fact that no representatives of the Viverridæ have yet been found in this country militates against the view of their origin in America, at least, from this source, although of course it is not impossible that migration may have taken place. The same argument applies to the Creodont *Miacis*, which has thus far been found only in the American Eocene.

RELATIONS OF THE CREODONTS TO THE FELIDÆ.—Schlosser has maintained that the feline phylum has been derived independently from the Creodonts.¹ Cope formerly held a similar view,² deriving the Felidæ directly from *Oxyæna*. Later he has changed his mind and now considers all the Carnivora as direct descendants of the Miacidæ.³ Scott has expressed a similar view⁴ and derives the Nimravidæ, which in turn gave rise to the Felidæ, directly from the Miacidæ.

With reference to the *direct* origin of the Nimravidæ *from any known Creodont*, the evidence heretofore has, however, been so meagre as to compel both Cope and Scott to reject the hypothesis as altogether conjectural.

Scott, in his excellent memoir already cited, observes: "No known group of Creodonts can be selected as having any *close* relations to the cats. The *Oxyænas*, it is true, do exhibit surprising analogies with this recent family, but the analogy is con-

¹ Ueber die Beziehungen ausgestorbener Säugetierfaunen und ihr Verhältnisse zur Säugetierfauna der Gegenwart. Biologisches Centralblatt, Bd. VIII.

² Tertiary Vertebrata, p. 264.

³ The Creodonta. American Naturalist, March, 1884, p. 262.

⁴ Notes on the Osteology and Systematic Position of *Dinictis felina*, Leidy. Proc. Acad. Nat. Sci., Phila., July 30, 1889, p. 242.

fined to the teeth, and is only superficial, *as the teeth, which in the two groups look so much alike, are not homologous*, and are developed in quite a different way." While this objection holds true of *Oxyæna* it does not necessarily apply to all the Creodonta, and if it can be shown that there is an Eocene genus of Creodonts, which fulfills the necessary requirements, then in our judgment it becomes equally, if not more probable that the ancestry of the Nimravidæ is to be referred to it, rather than to any group which has not been shown as yet to precede it in time.

Judging from the tooth and skull structure of the Nimravidæ, what characters would one be led to look for in their ancestors? We would say that in the upper jaw there should be a short muzzle, well-developed canines, a wide palate posteriorly, rapidly diverging tooth lines, marked tendency to molar reduction, and a large infraorbital foramen. In the lower jaw there should be a moderately deep ramus, straight upon its lower border, a flattened, truncated symphysis, an inferior dental foramen placed well below the tooth line, a distinct scroll-like condylar facet and a reduced second true molar.

PALÆONICTIS AND THE FELIDÆ.—These conditions we have fulfilled completely in the genus *Palæonictis*; the muzzle is short and the infraorbital foramen large, reminding one at once of *Dinictis*. The palate is relatively short and broad posteriorly; the second upper molar (*m*²), although present, is reduced quite as much as is the first true molar of the existing cats, having but a single root and a degenerate crown. The fourth superior premolar, while it does not display the perfect blades of the well-developed sectorial, nevertheless possesses the required primitive elements from which this tooth has been developed. The blades of the inferior sectorial (*pr*³ and *pa*³) produce a distinct 'shear' against the posterior and outer median cusps, as is demonstrated by the increased wear at this point. (See Fig. 5 *F*, and Plate IV.)

In the lower jaw we note the deep ramus with the comparatively straight inferior border; the inferior dental foramen is situated well below the tooth line, the symphyseal region is relatively broad and truncated, and the condylar facet has the distinctively scroll-like pattern seen in the cats. The second true molar is reduced in size, smaller than the sectorial, while the

sectorial itself has a relatively large talon and internal tubercle. The two blades of the sectorial are comparatively little developed, and they occupy a position at a considerable angle to the long axis of the jaw. The internal and external tubercles of the anterior triangle form a subsidiary blade which shears against the anterior edge of the internal tubercle of the first upper true molar, as is demonstrated by the wear exhibited in this situation.

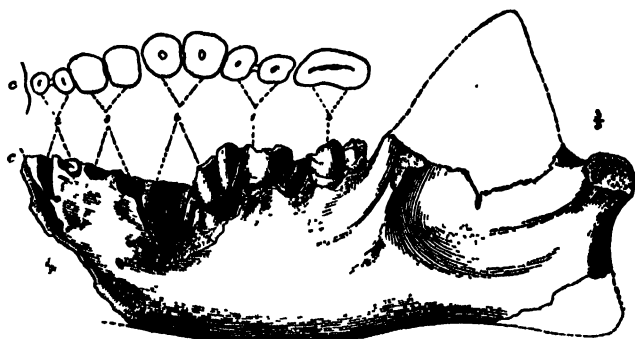


Fig. 4. *Patriofelis ulta*, type specimen, National Museum. External view of left lower ramus. Alveoli of teeth from above. Three-fifths natural size.

Patriofelis ulta Leidy.

As will be noted, *Palaeonictis* has been found thus far only in the lower Eocene (Wahsatch and Suessonian), and before we are able to establish a connection with the Miocene forms it is necessary to know something of its successors in the Wind River and Bridger formations which lie intermediate. The only specimens known to us from the Bridger which can be related to *Palaeonictis* are the type of *Patriofelis* Leidy, and an undescribed jaw in the Princeton Collection which Professor Scott has kindly placed at our disposal.

We may first consider the former. As shown in Fig. 4, and described by Leidy, the inferior dentition of *P. ulta* is probably $p=3$, $m=2$. The fourth premolar is the best preserved tooth; it is relatively larger than the first true molar, judging by the proportionate measurement of the fangs. The outer face of the crown and the characters of the deuterocone, or posterior basal

cusps, are closely similar to the corresponding parts in *Palaenictis* and *Ambloctonus*. The first true molar of the *Patriofelis* type is badly broken. The second true molar is proportionately larger than in *Palaenictis*.

? *Patriofelis leidyana*, sp. nov.

The Princeton specimen (Fig. 5, C,) may be provisionally referred to the same genus, and distinguished as *P. leidyana*. The specific character is that the fourth lower premolar is smaller than the first true molar. It carries the third and fourth premolars together with the first molar or sectorial. It also bears distinct traces of the canine alveolus, which serves to demonstrate *that the complete jaw contained but three premolars*, the first of which was probably small and single rooted. The length of the tooth line indicates that the jaw was short, resembling in this respect some of the modern cats. The principal interest, however, centers in the first true molar, or sectorial, in which we observe all the elements of the corresponding tooth in the most generalized forms of the Nimravidæ, but also just such an advance over the sectorial of *Palaenictis* as the sectorial of *Felis* advances beyond that of *Dinictis*. In this specimen we note that the two blades are much better developed than in *Palaenictis*, and occupy a position almost if not quite parallel with the long axis of the jaw. The internal tubercle and talon are much reduced. The posterior faces of the external and internal tubercles are rounded, not flattened as in *Palaenictis*, and there is no evidence of a secondary shear between this part of the tooth and the anterior edge of the internal lobe of the first upper true molar, which would have undoubtedly been the case if this part of the upper tooth had been well developed.

This evidence leads indirectly to the supposition that the first upper molar was considerably reduced, which in turn would seem to justify the inference that the last upper molar had completely disappeared. While this view is of course inferential, it is nevertheless strongly suggested by what we know of other forms, as, for example, *Amblyctonus*. The points of wear in one series and a knowledge of the lobes and cusps which produce it

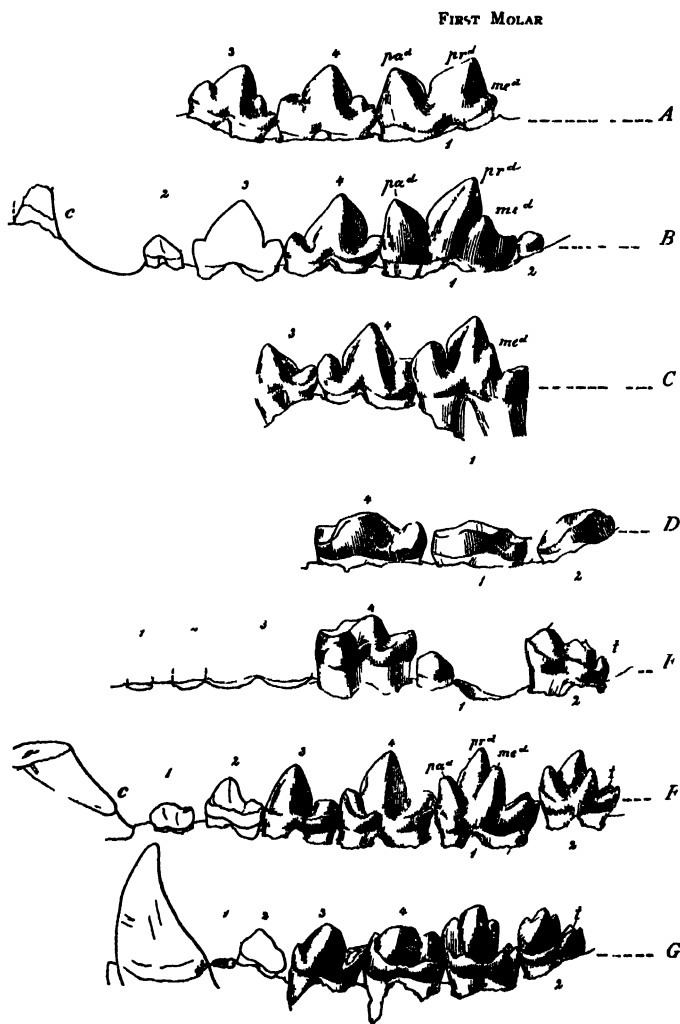


Fig 5. Series of types showing (1) the evolution of the Sectorial Molar, (2) the reduction of the *Talon*, *t*, of the second molar in the *Palaeonictidae*. All figures natural size.

A *Felis concolor* (inner view)
 B *Dinictis felina* "
 C ? *Patriofelis leidyani* "
 D *Ambloctonus* (outer view)

E *Ambloctonus sinosus* (inner view)
 F *Palaeonictis occidentalis* "
 G *Palaeonictis gigantea* (outer view)

in the other, is of the utmost importance in determining the relationship between the upper and lower teeth. This is of all the greater moment when we have to deal with a rapidly degenerating series of teeth, as we do in the present instance. When the complete dentition of this interesting form is known, we are induced to predict from the evidence already cited that it will be found to have but a single upper true molar much better developed than in any of the *Nimravidæ* at present known, that there will be found to be two true molars in the lower jaw, with the last one intermediate between the conditions now exhibited by *Dinictis* and *Palæonictis*, that the premolars will be three in the lower and three or four in the upper jaw, and that altogether it will display marked affinities in the direction of the *Nimravidæ*.

CONCLUSIONS.—The evidence which we here present in favor of the derivation of the cats from the *Palæonictidæ* is based solely upon a consideration of the teeth and of the form, so far as we can judge, of the jaws, but it may transpire that when the skeleton of *Palæonictis* is discovered there will be difficulties presented which will invalidate this evidence; and before we are in possession of such facts any final judgment in the matter must be regarded as premature. However, we have deemed the matter of sufficient importance to discuss it thus fully. The evidence may be summed up as follows:

In favor of this genetic relationship:

1. *Palæonictis* presents the same mode of dental reduction as the *Nimravidæ* and *Felidæ*, namely: rapid loss of the posterior pair of upper and lower molars and of the anterior premolars.
2. It presents the same sectorials as the *Felidæ*, namely: the fourth upper premolar and first lower molar.
3. It presents the feline conformation of the skull.

Against this relationship:

1. *Palæonictis* and *Patriofelis (ulta)* show an enlargement of the fourth lower premolar not observed in the *Felidæ*.
2. The evidence rests solely upon the teeth, as the foot structure and skeleton of *Palæonictis* is unknown.

A conservative conclusion based upon our present evidence is that the *Palaeonictidæ* were a family of Creodonts from which the *Felidæ* may have sprung. No other known Creodonts present so many points of resemblance with the cats, or the possibilities of such derivation.

The mode of dental reduction, the homologies of the lower molar cusps, showing the rise of the sectorial by the development of the paraconid and protoconid, are beautifully shown in the above series of figures. (Fig. 5, A-G.)

IV.—TAXONOMY AND MORPHOLOGY OF THE PRIMATES, CREODONTS AND UNGULATES.

1.—*Wahsatch Fauna.*

Order PRIMATES.

The collection is very rich in the Lower Eocene Monkeys, containing four specimens of *Anaptomorphus*, forty of *Hyopsodus*, sixteen of *Pelycodus*, two of *Cynodontomys*, and several specimens which cannot be determined.

CLASSIFICATION OF THE FOSSIL PRIMATES.—It seems probable that the Anaptomorphidæ belong to the Lemuroidea, although this reference rests merely upon the external position of the lachrymal foramen in the type skull of *Anaptomorphus homunculus*, and we have not at present any means of determining whether the inferior caniniform tooth is a true canine, as in the Anthropoidea, or is a modified first lower premolar as in the typical Lemuroidea.

The other Eocene Monkeys, such as the Adapidæ, the Notharcidæ (= Limnotheridæ, Marsh), and the Microsyopsidæ have also been usually placed in the Lemuroidea, but there is absolutely no ground for this reference; while there are, on the other hand, many reasons to believe that they are primitive Anthropoidea, and that they bear somewhat the same relation to the modern Anthropoidea that the Eocene Perissodactyla bear to the modern

Perissodactyla. At least, there are no means of separating them from this suborder.

Schlosser was the first to unite the Eocene Monkeys of Europe in the 'Anthropomorphæ,' but he has inconsistently separated the American Monkeys as 'Pseudo-lemuroidea,' a division which if valid is preoccupied by the 'Mesodonta' which Cope has abandoned.

Sub-order LEMUROIDEA.

Family ANAPTOMORPHIDÆ Cope.

This family is distinguished by its extremely reduced dentition; the premolars are unlike the molars, and are 3-2 in number; there are but two lower incisors, and apparently a true canine; the upper molars are tritubercular; the lower molars are quinquetubercular or quadritubercular.

A comparison of Leidy's type of *Omomys*, from the Middle Eocene (Bridger), with Cope's specimens and those in the American Museum, shows that it probably belongs in this family, although a small second premolar persists as in the Wahsatch species of *Anaptomorphus* (*A. homunculus*), and the chin is more elongate and less rounded than in *A. æmulus* from the Bridger. In every detail of dental structure, excepting the above, *Omomys* closely resembles *Anaptomorphus*.

Genus *Anaptomorphus* Cope.

It will be remembered that Cope's type (*A. æmulus*) of this genus is a lower jaw with the formula I ₂, C ₁, P ₃, M ₃. He subsequently referred to the same genus the species *A. homunculus*, founded upon a skull (without the jaws) from the Wahsatch. It is interesting to record the discovery of a specimen from the Wahsatch in which a nearly complete lower jaw is associated with upper teeth identical with those of *A. homunculus*.

Anaptomorphus homunculus Cope.

The best specimen (No. 41) consists of portions of the two maxillæ containing two premolars and three molars, and of a lower jaw containing the corresponding teeth.

As might have been anticipated, the inferior true molars are in a slightly earlier stage of evolution than those in the Bridger species. Cope has described the molars of *A. æmulus* as "quad-

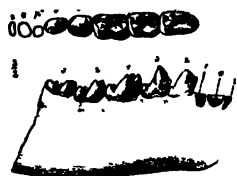


Fig. 6. *Anaptomorphus homunculus*: external view of lower jaw and crown view of teeth. $\frac{1}{2}$ natural size.

ritubercular," but more strictly speaking, the first and second molars are quinetubercular, for they display rudiments of the fifth tubercle or paraconid, and are transitional. In the jaw of *A. homunculus* we find the paraconid more distinct upon the first true molar, and gradually decreasing in size upon the second and third. The third and fourth premolars are similar to those in

A. æmulus, but the internal cuspsule is not visible upon the fourth. A more important primitive character is indicated by a very small alveolus for the root of a *second premolar* upon the outer side of the jaw, so that the formula of this species should probably be written: Premolars, $\frac{1}{2}$. Molars, $\frac{3}{2}$ = *A. homunculus*. We cannot determine whether there is also a trace of the second premolar in the maxilla. Three other specimens (Nos. 42, 43, 44) may be similarly referred.

Order CREODONTA *Cope*.

This order is represented in the collection by specimens belonging to all the known Wahsatch families, namely the new family Palæonictidæ, the Oxyænidæ, the Miacidæ, the Proviveridæ, the Mesonychidæ and the Arctocydonidæ.

Family PALÆONICTIDÆ.

The material at our disposal indicates that *Palæonictis* belongs to a distinct family of Creodonts. Cope has in fact placed it with *Ambloctonus* in the Ambloctonidæ, although he misinterpreted the dental formula of *Ambloctonus*, owing to the extremely fragmentary condition of the type.

It is important to distinguish these forms clearly from the Oxyænidæ, with which they present a superficial resemblance.

Paleonictidæ.

Face short. Fourth upper premolar and first lower molar, only, developing into sectorial. Dental reduction the same as in *Felidæ* (i.e., m. $\frac{3}{4}$ and $\frac{1}{2}$ disappear).

Oxyenidæ.

Face long. Fourth upper premolar and first upper molar, first and second lower molars developing into sectorials. Dental reduction unlike that in *Felidæ* (i.e., m. $\frac{3}{4}$ disappear).

The *Paleonictidæ* are distinguished readily from the *Proviveridæ* (to which the contemporary *Stypolophus* belongs) by the extreme reduction of the upper and lower true molars.

Family *Paleonictidæ*.

Paleonictis: I $\frac{3}{4}$, C $\frac{1}{2}$, P $\frac{1}{4}$, M $\frac{1}{4}$. Second upper molar very small. Second lower molar with well-developed talon. First lower molar tuberculo-sectorial.

Ambloctonus: I $\frac{1}{2}$, C $\frac{1}{2}$, P $\frac{1}{4}$, M $\frac{1}{4}$. Second upper molar absent. Second lower molar with talon rudimentary or wanting.

Patriofelis: I $\frac{1}{2}$, C $\frac{1}{2}$, P $\frac{1}{4}$, M $\frac{1}{4}$. (First lower molar sub-sectorial.)

Genus *Paleonictis* De Blainville.

P. gigantea DE BLAINVILLE. Talon of second lower molar long, with three cusps. (Suessonian of France.)

P. occidentalis, sp. nov. Talon of second lower molar short, with a single cusp. (Wahsatch of America.)

Genus *Ambloctonus* Cope.

A. sinosus COPE. Talon of second lower molar wanting, or reduced to a spur. (Wahsatch.)

Genus *Patriofelis* Leidy.

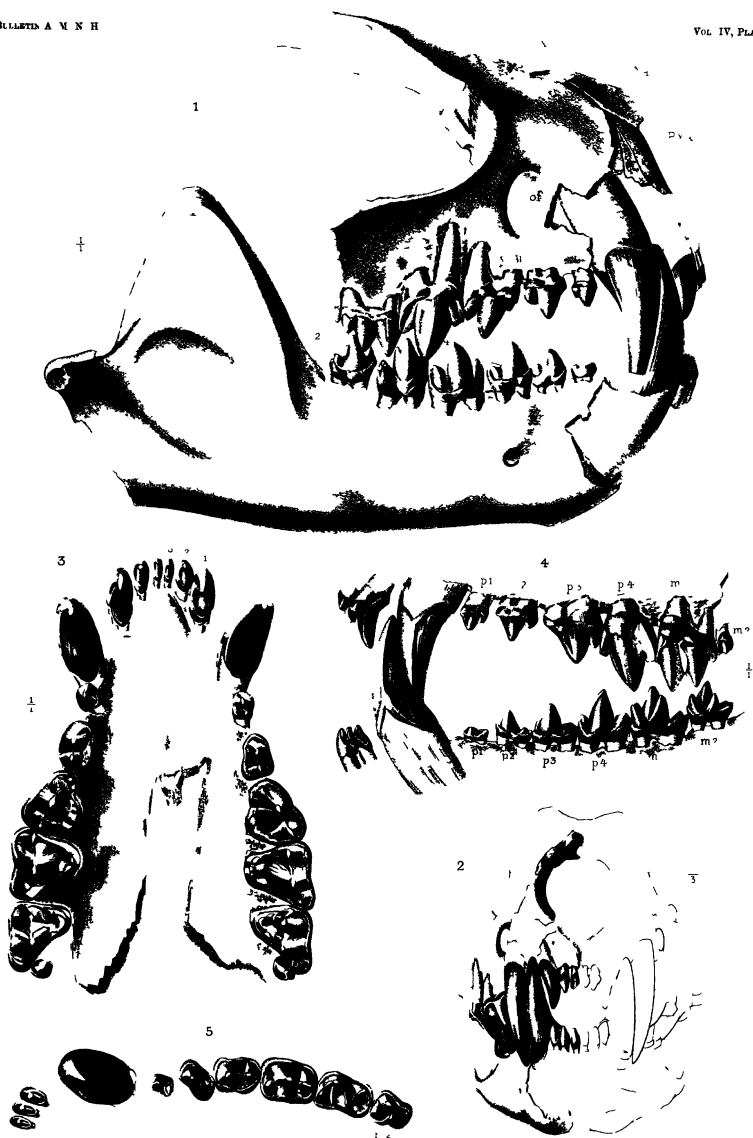
P. ulta LEIDY. Fourth lower premolar larger than first molar.

P. leidyani, sp. nov. Fourth lower premolar smaller than first molar.

Paleonictis occidentalis, sp. nov.

PLATE IV.

It is important to establish at the outset the generic status of the type specimen. Its reference to *Paleonictis* rests upon the absolute similarity of detail in the structure of the lower teeth with those of De Blainville's types, which are two fragmentary lower jaws containing the third and fourth premolars and two molars. The specific distinction of *P. occidentalis* is the degeneration of the talon of the second lower molar. *Ambloctonus* is very close to *Paleonictis*, if not actually identical, but it may for the present be distinguished by the presence of but one upper molar. (See Fig. 5, *D*, *E*, *F*, *G*. Also Fig. 8.)



PALAEONICTIS OCCIDENTALIS

The skull of the type (No. 110) of this species has been described under Section III, page 96. The dentition is that of a young individual, and is beautifully preserved. Both of the rudimentary second upper molars were procured, but one of them was unfortunately lost. No other remains were found. All the characters of the skull and teeth are brought out in the lithographic plate.

The animal was one-fourth larger than the American Puma (*Felis concolor*), and slightly larger than either of the specimens referred to *Palaeonictis gigantea* by De Blainville and Gaudry. As in *F. concolor* the lower incisors are of nearly equal size; while the upper increase rapidly outwards, the first being very small and the third being large and caniniform. The canines are large, vertically striated and recurved; they exhibit an internal ridge extending from the posterior base to the apex.

Lower Series.—The first lower premolar is low and obtuse with a distinct talon. The second has a pointed protocone, a more elevated talon, and a faint external cingulum. The third has a higher protocone, a prominent basal cusp, and distinct external and internal cingula. The fourth premolar is tricuspid, and exhibits a cusp analogous to the paracone (tetartocone, Scott); also the more elevated basal cusp, rising from the talon and analogous to the hypoconid (=deuteroconid, Scott). The cingulum completely encircles the crown, except at the ends, and upon the inner side of the talon is marked by a little tubercle. The first true molar is a fine example of the typical "tuberculo-sectorial" type. The elevated trigonid supports the lofty protoconid and subequal para- and metaconids, while the talon supports three subequal cusps, the hypoconid, the hypoconulid or posterior intermediate cusp, and the entoconid. The second molar is of much smaller size; the trigon bears a reduced metaconid, while the talon is still more reduced by the loss of the two internal cusps, the hypoconid alone persisting.

Upper Series.—The first upper premolar is small and single fanged, with a minute basal cusp. The second has quite a prominent basal cusp with a faint external and an internal cingulum shelf. The third premolar has almost a blade or shear formed by the protocone and deuterocone or basal cusp, and a crenate cingulum shelf. The fourth premolar is, we believe, the incipient sectorial; it has the three external cusps which compose the upper sectorial of *Felis*, but the middle cusp, or protocone, is much the most prominent; this with the posterior cusp (deuterocone) forms a sharp-edged shear, against which abuts the shear formed by the paraconid and metaconid of the first lower molar. Herein lies a close resemblance to the relations of these two teeth in the Felidae, and these molars furnish a simple key to the feline sectorials, as shown in the accompanying diagrams. (Fig. 7.)

The transformation of the feline upper premolar has taken place by the subequal development, *A*, *B*, of the three external cusps, *te*, *pr*, and *de*, and by the shifting forward of the internal

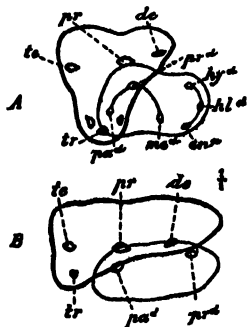


Fig 7 The homologies of the Molar Cusps in the Felidae: *A*, *Palaeonictis occidentalis* *B*, *Felis concolor*. *de*, deuterocone *tr*, triticocone. *te*, tetartocone. Last upper premolar and first lower molar in opposition.

cusp *tr*. Meanwhile the lower molar has lost the entire talon (*hy*^d, *hl*^d, *en*^d) and the metaconid (*mc*^d) is reduced to a rudimentary stage in which it is barely perceptible. This conforms with the description of this transformation given by Cope,¹ but adds a more exact statement of the homologies of the cusps. The degeneration of the metaconid is well shown in the series of sectorials exhibited in Fig. 5.

The reduced condition of the upper true molars of *Palaeonictis* is most remarkable in an animal of such an early period as the Wahsatch. The third molar has disappeared entirely, the second has been reduced to an extremely small rounded tooth; the first molar is already smaller than the fourth premolar. The pattern of the first upper molar is somewhat similar to that of *Oxyaena*, but the protocone is directly internal instead of being pushed forwards; the external cusps, paracone and metacone, are subequal and slightly compressed; on the trigon between these high cusps and the low protocone are small intermediate tubercles, *pl*. and *ml*. There is a prominent cingulum and a posterior basal cusp.

Ambloctonus sinosus Cope.

The skull of *Palaeonictis* renders a great indirect service in enabling us to clear up the structure of the enigmatical *Ambloctonus*. This was established upon a much fractured maxilla and mandible, by which Cope was wholly misled as to the notation and homologies of the teeth and the relationships of the genus, although in the 'Tertiary Vertebrata' he placed it near *Palaeo-*

¹ The mechanical causes of the development of the Hard Parts of the Mammalia. *Journal of Morphology*, Vol. III, 1889, p. 232.

nictis. Schlosser has rightly discerned the resemblance between these forms.

The accompanying figure presents our interpretation of this fractured type. There are two lower molars and but a single upper molar; the maxilla turns sharply in behind the first molar,

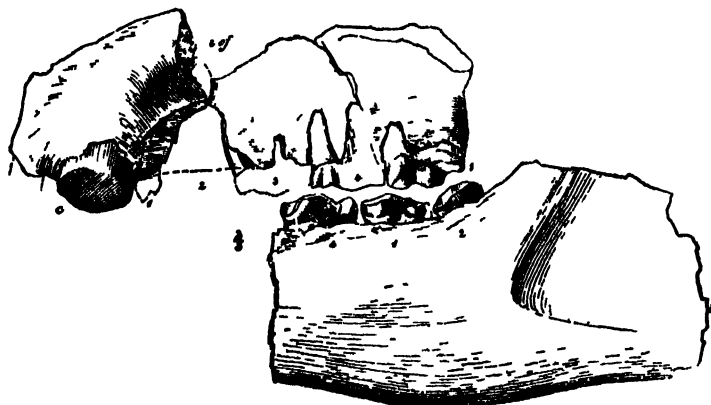


Fig 8 *Ambloctonus sinensis*, type specimen, National Museum. This drawing is a composition of the left mandible and right maxilla of the same individual. Three fifths natural size.

and leaves no doubt as to the absence of both the second and third upper molars. The gap between the fourth premolar and first molar does not contain an extra tooth, as Cope supposed. The tooth Cope mistook for the first molar is really the fourth premolar; the gap in the jaw closes up when the matrix is removed. The superior formula was therefore undoubtedly $p=4$, $m=1$.

This interpretation is supported by the structure of the lower molars, *i.e.*, by the marked degeneration of the talon of m_2 which it is obvious has nothing to abut against in the upper jaw. Two stages in the reduction of this talon are shown in Fig. 5; in the type specimen *D*, there is no talon; in a second specimen, rightly associated with the genus by Cope (see Fig. 5, *E*), there is a rudimentary talon, *t*.

Family OXYÆNIDÆ Cope.

This family is represented in the collection by eight specimens belonging to the two well-known Wahsatch species, *O. lupina* and *O. forcipata*.

Genus *Oxyæna* Cope.

They enable us to add several important family and generic characters. Cope has defined the genus as probably possessing no inferior incisors. (1) We find that there are three incisors in both the upper and lower jaws, as in *Palæonictis*. (2) A tarsus of *P. forcipata* in the collection does not support Cope's view that there was a cleft between the third and fourth digits. (3) There is an os-centrale in the carpus. (4) The lumbar vertebræ have involuted zygapophyses. (5) The femur has a faint rugosity representing the third trochanter.

Oxyæna lupina Cope.

We have referred to this species portions of three lower jaws (Nos. 102, 103, 104), and a fragmentary lower molar (No. 105); also the fairly complete skeleton and teeth of a single individual (No. 107).

The Manus of Oxyæna.—As noted by Cope, the skeleton of *Oxyæna* is much smaller and lighter in proportion to the skull than in the Carnivora.

The scaphoid rests upon the trapezium, trapezoid (which is the only carpal missing), and centrale. It is entirely distinct from the lunar. The lunar rests inferiorly, by nearly subequal facets, upon the centrale and unciform, with a narrow anterior and broad posterior contact with the magnum. The cuneiform rests upon the oblique outer surface of the unciform. The trapezium is depressed so as to form a lateral internal support for the second digit. The magnum presents a subquadrate anterior outline. The unciform has an internal contact with the middle digit, and an oblique external facet for the fifth. The metapodials are much shorter, more spreading, and less firmly interlocking than in the Felidæ.

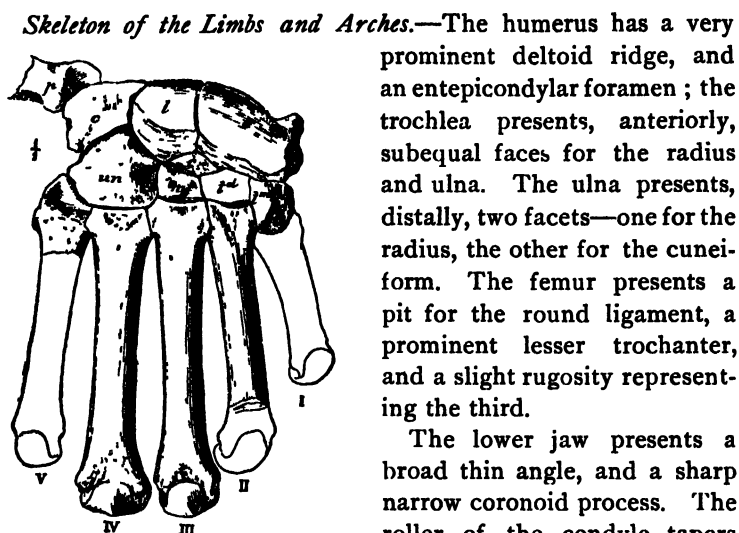


Fig 9. *Oxyæna lupina* Right manus, natural size

Skeleton of the Limbs and Arches.—The humerus has a very prominent deltoid ridge, and an entepicondylar foramen; the trochlea presents, anteriorly, subequal faces for the radius and ulna. The ulna presents, distally, two facets—one for the radius, the other for the cuneiform. The femur presents a pit for the round ligament, a prominent lesser trochanter, and a slight rugosity representing the third.

The lower jaw presents a broad thin angle, and a sharp narrow coronoid process. The roller of the condyle tapers sharply, as in *Felis*.

Oxyæna forcipata Cope.

We have referred to this species portions of two skeletons (Nos. 108, 109), distinguished by the heavy character of the bones. They include a tarsus, which agrees closely with that referred to this species by Cope, with the exception noted above. The former has two lower teeth associated with it, but they are so broken that the reference is uncertain. A jaw (No. 106), containing fragmentary molars, may also be placed here.

The *tarsus* (No. 109) is extremely interesting, as it appears to prove that Cope is mistaken in his description of the hind foot of *Oxyæna*. The calcaneum is complete and presents an oval ectal facet and a subcircular sustentacular facet. The astragalus lacks the outer portion of the tibial trochlea; Cope's figure indicates that the tibial facet is very limited in the fore and aft direction, and that therefore *Oxyæna* was a plantigrade; unfortunately this pes does not throw any light upon this point. A very striking feature of the foot is the broad contact between the cuboid and astragalus; the cuboid is, as represented by Cope, directed outwards, but the *ectocuneiform* is in close contact with it, proving that

there could not have been a cleft between the third and fourth toes. The entocuneiform is a high narrow bone; the mesocuneiform was evidently shorter.

The femur (No. 108) is remarkable for its heavy distal extremity, and its clumsy tibial and patellar facets. The tibia is correspondingly massive. The dorsals and lumbar are partly preserved. The latter have a short, rather obtuse, transverse process, and elevated zygapophyses interlocking by strongly concavo-convex facets.

Family PROVIVERIIDÆ.

Genus *Stypolophus* Cope.

This genus is represented by eight specimens (Nos. 94-101), some of which are in good preservation. There are three specimens (Nos. 96, 97, 98) belonging to *S. whitæ* Cope; two are referred to the smaller form *S. viverrinus* Cope (Nos. 94, 95); and one well-preserved specimen is much larger than any form of *Stypolophus* hitherto described (No. 99).

Family MIACIDÆ.

Genus *Miacis* Cope.

Dentition I₃, C₁, P₄, M₈. First true molar tuberculo-sectorial; second and third molars tubercular.

Miacis canavus Cope.

A lower jaw (No. 83), which represents this species, has the symphyseal region well preserved, and enables us to determine the *alveoli of three incisors*, the number of these teeth having been hitherto unknown. The symphysis is narrow, and the alveoli are very crowded, indicating that the incisors were rather small. As described by Cope, the canine is large and compressed; the first premolar is single rooted; the second has two small roots; the third is larger; the fourth consists of a trenchant protocone, with faint anterior and a well-defined posterior basal cusp. The first molar is tuberculo-sectorial, with a rounded talon; the second is tubercular; the third is missing, and is represented only by the small alveolus.

There is a single second or third upper molar of the right side belonging to another individual (No. 85), which we provisionally refer to *Miacis*. It is distinguished from the corresponding teeth in *Stypolophus* by the broad external extension of the cingulum which supports no less than four low conical cusps outside of the typical pair of external cusps—the paracone and metacone. The intermediate tubercles are fairly well developed; the protocone is prominent.

Several other specimens can only be provisionally determined. A fragment (No. 84), containing the two lower tuberculars, we refer to *M. brevirostris*, as it is found in the Wind River. A second specimen (No. 87) contains a first lower tubercular of an individual much smaller than *M. canavus*, and there is a still smaller specimen (No. 86), which agrees in size with *M. edax* Cope, from the Bridger.

Genus *Didymictis* Cope.

This genus is characterized by two lower molars, one of which is of a tuberculo-sectorial type, while the other is tubercular and usually is a long somewhat narrow tooth. A well-preserved anterior triangle (trigonid) characterizes the Wahsatch species. The following determinations are not critical; they are based wholly upon Cope's diagnoses.

The two smallest jaws in the collection may be referred to the smallest form, *D. dawkinsianus* Cope (Nos. 89, 90). Together they contain the third and fourth premolars, and first and second molars. They are even smaller than Cope's types.

A much larger individual (No. 92) agrees with the type of *D. curtidentis* Cope; this contains the first and second molars. The second molar, which has not been previously described, is long and rather narrow, with the typical three tubercles upon the trigonid and an elevated talonid. A second specimen (No. 93), containing the fourth premolar and first molar, may be referred to the same species, although the individual is somewhat smaller.

D. leptomytus Cope is represented by the posterior portion of a right mandible, an upper molar and numerous fragments. The upper molar resembles those of *Stypolophus whitiae*; it has a single prominent tubercle upon the external cingulum.

Family MESONYCHIDÆ Cope.

This family, which is so well known through the writings of Cope and Scott, extended from the Puerco into the Bridger period. It is represented in the present collection by two species of *Pachyæna*, one of them new, and by a small jaw which we provisionally refer to *Dissacus*, a genus hitherto found only in the Puerco.

Dissacus leptognathus, sp. nov.

The species is distinguished from the Puerco forms (*D. navojivius* and *D. carnifex* Cope) by the extreme reduction of the postero-internal cusp (metaconid) of the trigon, which is partly separated from the protoconid.

The type is a portion of a small right mandible (No. 78), containing the second true molar complete and the broken crowns of the first molar and fourth premolar. It is reproduced, natural size, in the accompanying figure, and is about half as large as the types of the Puerco species. The characters of the molar cusps are evidently transi-



Fig 10. *Dissacus (Pachyæna) leptognathus*, type. Inner aspect of right mandibular ramus.

tional between those of *Dissacus* and *Pachyæna*, so that the species might be referred to the latter genus.

The fourth premolar has a single main cone, the protoconid, and a sharp thin basal cusp or talon. The second molar has a small paraconid in the same line with the protoconid; the latter has a faint trace of the metaconid upon its inner slope; the hypoconid is proportioned as in *Pachyæna*.

Pachyæna ossifraga Cope.

The Wahsatch *Pachyæna* is distinguished from *Mesonyx* of the Bridger by the possession of three true molars in both jaws. The formula is I $\frac{3}{2}$, C $\frac{1}{1}$, P $\frac{4}{1}$, M $\frac{3}{2}$. The last upper premolar is molariform.

The only Wahsatch species hitherto known is the *P. (Mesonyx) ossifraga* Cope. We find three specimens in the collection which

we can refer to this species. They consist of scattered lower teeth (No. 74); a fairly perfect left mandibular ramus, containing the third and fourth premolars and first molar (No. 75); and a single lower molar (No. 76).

Pachyæna gigantea, sp. nov.

This species is founded upon a series of finely-preserved upper

cheek teeth lacking only the first premolar. The specific distinctions from *P. ossifraga* are very marked:—(a) the presence of a metacone upon the third upper molar; (b) the more complex structure of the third and fourth premolars; (c) the very broad crenate external cingulum; (d) the relatively smaller size of the metacone in the molars.

The name is given in reference to the very large size of the animal. Prof. Cope estimates that *P. ossifraga* was as large as the largest Grizzly Bear (*Ursus horribilis*). Prof.

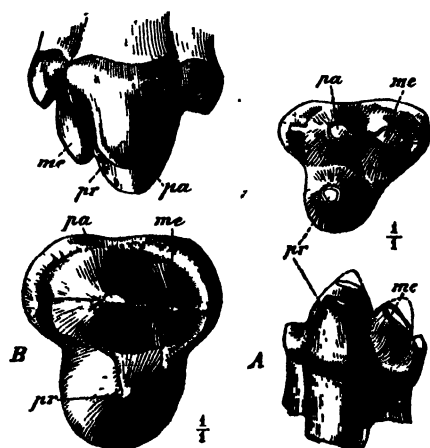


Fig. 11 A, *Pachyæna gigantea*, first superior molar of type, internal and crown views. B, *Pachyæna ossifraga*, type, fourth premolar or true molar, same views (National Museum). Both figures natural size

Scott¹ has shown, however, that the Mesonychidæ were characterized by very large heads, and small, rather feeble bodies. Even with this reservation, while *M. lanius*, as restored by Scott, was 4½ feet long, *P. ossifraga* must have been over five feet, and *P. gigantea* was over seven feet or more than two metres in length. This is by far the largest of the Creodonta excepting the *Mesonyx uintensis* of the upper Eocene.

The main features of the teeth are (1) the very prominent cingulum; (2) the small size of the second external cusp (metacone);

¹ Journ. Acad. Nat. Sci. Phila., Vol. IX, 2d Ser., Pl. VI, 1886.

(3) the prominent ridge upon the postero-external slope of the protocone.

The second premolar is fractured upon the inner side, leaving us in doubt as to whether there was an internal cusp. The protocone is a high and compressed cone with a slightly ovate pos-



Fig. 12. *Pachyana gigantea*. Crown view of superior molars of right side. Two-thirds natural size.

terior edge. In the third premolar the postero-internal cingulum rises into the basal talon (deuterocone); also into the internal basal shelf (trittocone), proving that both these cusps arise as *cingules* in the premolar series. The corresponding tooth in *P. ossifraga* has no internal lobe, as figured by Cope. The next tooth is completely molariform; it is much larger than the preceding, and much more worn than the first molar, suggesting the possibility that it may be a milk tooth, or that in this species the fourth premolar may receive an unusual amount of wear. Since all the teeth are isolated the position of the premolars is somewhat uncertain.

The first true molar presents a complete external cingulum rising at either end of the external lobe into high cingules; the metacone is much smaller than either the protocone or paracone. The second and third true molars exhibit a slight reduction in size; the external cingulum is less complete, and the metacone is gradually reduced.

Another specimen (No. 73), belonging to the same species, confirms the characters here assigned as distinguishing *P. gigantea* from *P. ossifraga*. In the true molars which are all well preserved, the metacone is even more reduced than in the type.

In premolar development *P. gigantea* is more progressive, but in the typical structure of the third molar it is more primitive than *P. ossifraga*.

The homologies of the lower molar cusps of these genera are rendered fairly certain by their derivation from those of *Dissacus*; the anterior cusp is the paraconid, the middle cusp is the protoconid, the posterior cusp is the hypoconid, the metaconid has entirely disappeared. The homologies of the upper cusps are somewhat uncertain; they appear to represent the typical trigonodont pattern with the protocone as the internal apex, and the paracone and metacone as the external base.

Family ARCTOCYONIDÆ Cope.

In this family we include the Creodonts with low crowned tubercular molars, as distinguished from those with one or more sectorial teeth. It contains *Arctocyon*, hitherto found only in France. We may, with Schlosser, provisionally add some of the forms described by Cope under *Mioclanus* of the American Puerco, and increase the list by *Anacodon* of the Wahsatch.

Anacodon was founded by Cope¹ in 1881 upon a portion of a lower jaw and some fragmentary lower molars. It has since remained one of the enigmas of the Wahsatch fauna. He placed it provisionally in the Phenacodontidæ.² The more complete material at our disposal still leaves its position somewhat uncertain, since we have no remains of the skeleton, but renders it very probable that it is a Creodont of a highly specialized type.

Anacodon ursidens Cope.

Dentition I $\frac{1}{1}$, C $\frac{1}{1}$, P $\frac{1}{1}$, M $\frac{3}{3}$. Upper molars tritubercular with a small hypocone. Lower molars quadritubercular. Premolars small, reduced in size and number. Coronal pattern obscured by crenulation of enamel.

There are three specimens in the collection, all of which were found in the uppermost Wahsatch strata. The first (No. 80) is a fragment of a lower jaw with the first and second molars in situ. The second (No. 81) consists of portions of two jaws with three molars, two premolars, and three upper molars. The third (No. 82) includes a palate with the upper molars and one premolar

¹ Proc. Am. Phil. Soc., 1881, p. 181.

² Tertiary Vertebrata, p. 427.

(Fig. 13) and the first and second lower molars. The latter corresponds in size with the type of *A. ursidens* Cope. The former two are smaller, but cannot be distinguished specifically. Both upper and lower series present a large second true molar, in front of which the teeth diminish rapidly in size, the fourth premolar is decidedly smaller and simpler than the first molar. The third premolar in the lower jaw is a diminutive tooth; this is preceded by a diastema indicating that the first and second premolars were still more reduced or possibly wanting. The first characteristic of the genus therefore is the striking reduction of the premolars which sharply distinguishes it from any of the Ungulates, as well as from any known Creodonts.

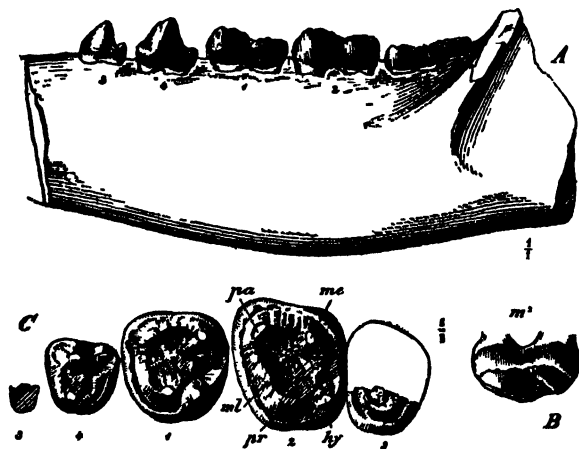


Fig. 13. *Anacodon ursidens*. A, Internal view of lower jaw. B, Crown view of upper molars. C, External view of second upper molar. Natural size.

The second characteristic is the excessive number of minute tubercles which cover the crown, and the extremely depressed summits of the cusps.

The upper true molars (Fig. 13, B, C), are completely surrounded by a cingulum, and upon the roughened unworn surface of the second we can just distinguish faint traces of the intermediate conules, *pl* and *ml*. Even the protocone is depressed; the talon is well developed in *m2*, giving the crown a subquadrate outline, but *m1* and *m3* are more triangular. There is in fact no

evidence of a hypocone upon m_3 , and it is feebly developed upon m_1 . The external cusps, pa and me , constitute the most elevated portions of the trigon. Only one upper premolar is preserved; this shows an elevated external cusp, and prominent internal cusp; in front of this is the alveolus of a small bifanged third premolar.

The lower molars (Fig. 13, *A*), consist of four cusps only—the protoconid, metaconid, hypoconid and entoconid. There is no trace of the paraconid or fifth cusp; and the hypoconulid, which is so prominent in *Phenacodus* and the Wahsatch Ungulates generally, is very faintly indicated in m_1 and m_2 by a slight elevation between the posterior pair of cusps. The third lower molar, however, has a well-developed third lobe, which invariably arises in the mammalia by a backward extension of the hypoconulid. Unlike the upper molars there is no trace of a cingulum. The fourth lower premolar is just emerging from the jaw (No. 81). It is only two-thirds the length and width of the first molar, thus presenting an extremely unique disproportion; it consists of a symmetrical protocone, with a concave posterior face and very slight indication of a talon. The third premolar is a diminutive tooth of the same form. In front of this is a diastema.

The characters and dimensions of the jaw are shown in the accompanying figure. The jaw was stout with a deep masseteric fossa. As regards the general structure of the dentition we must emphasize the following peculiarities:

1. The enlargement of the second molar in both jaws, the smaller size of the first and third, and the very marked reduction of the entire premolar series. There is no evidence that there were more than two premolars, and these were very small.
2. The degenerate condition of the cusps of the molars, and the formation of innumerable secondary tubercles or crenations.
3. The probable presence of a wide diastema.

Altogether *Anacodon* was a degenerate and highly specialized animal.

As regards its affinities they are certainly nearer *Arctocyon* than any other known fossil form, in fact there are many striking re-

semblances between these Wahsatch and Suessonian (Cernaysian) genera.¹ The older species of *Arctocyon*, the *A. primævus* of de la Fère, have four complete premolars and are much larger, but the type of the more recent species *A. gervaisii* (type of *Hyodectes* Cope) has but three premolars, and is of exactly the same size as our smaller specimens of *Anacodon*; in this species the anterior premolars *pm2* and *pm3* are being rapidly reduced (Lemoine, op. cit., Plate II), although the fourth is still of large size. Further similarities are seen in the absence of the paracoenid in the lower molars, in the broad cingulum of the upper molars, but mainly in the proportions of the upper molars (Osborn, op. cit., fig. 4), and relative development of the hypcone. Lemoine has figured accessory tubercles upon the lower molars of *A. gervaisii*.

The main difference between *Anacodon* and *Arctocyon* is the greater reduction in the premolars of the former. In the successive species of *Arctocyon* we however observe marked incipient tendencies to premolar reduction, which may have been carried further in *Anacodon*.

If these views are supported by additional evidence, we shall regard the bunodont Creodonta as first seen in *Miocænus* of the Puerco, again represented in *Arctocyon* belonging to a period overlapping the Puerco and Wahsatch, and culminating in the summit of the Wahsatch in *Anacodon*.

Order AMBLYPODA *Cope*.

Suborder PANTODONTA' *Cope*.

Family CORYPHODONTIDÆ *Cope*.

Genus *Coryphodon* *Owen*.

The collection is very rich in remains of *Coryphodon*, the typical genus of the Wahsatch beds, including one specimen represented by the fore and hind limbs, feet and pelvis; the cervical vertebrae

¹ See Lemoine, Etude du Genre *Arctocyon*. Ann. d. Sciences Naturelles, July, 1878, Vol. VIII, No. 1. Also Osborn, A Review of the Cernaysian Mammalia. Proc. Acad. Nat. Sci., Phila., 1890, p. 51.

² This is equivalent to the *Coryphodontia* of Marsh.

and upper molars of another individual ; a complete series of upper teeth of the largest type ; upper and lower jaws of another specimen ; the lower jaws of a young individual containing the milk dentition ; and a large number of isolated teeth, limb-bones, foot-bones and vertebræ.

All the specific determinations proposed by Cope have, with the exception of the types of *C. pachypus* and of *C. anax*, been based upon the teeth, and the present collection has materially aided in clearing up the great confusion in nomenclature. Mr. Charles Earle, Assistant in Palæontology, has undertaken a complete revision of the nomenclature of the American Coryphodontidæ which will soon be published in this Bulletin. We are indebted to him for all the determinations and references here made.

Coryphodon radians *Cope*.—This species is represented by a complete series of maxillary teeth, and the cervical vertebræ of one individual (No. 274). There is also a complete series of inferior molars, premolars and canines (No. 259). Also a number of superior molars (No. 267). The above are from the Wahsatch.

From the Wind River beds we also find two last lower molars which cannot be distinguished from those of *C. radians*, together with many portions of the skeleton.

Coryphodon elephantopus *Cope*.—This species is represented by remains of one individual (No. 275), including the occipital and palatine region of a skull containing the true molars and premolars, excepting *pm* 1. This is very similar to the type of *C. hamatus* Marsh. Another individual (No. 260) contains portions of the third upper molar, of the lower canines and incisors. This species is very similar to the foregoing.

Coryphodon obliquus *Cope*.—This is represented by a nearly complete lower jaw (No. 276) lacking the incisors, and the upper molars and premolars. The value of this specimen lies in the somewhat unusual association of upper and lower teeth.

Coryphodon anax *Cope*.—As indicated by the name this is the largest species, and it probably includes *C. pachypus* Cope. The principal specimen is a skeleton without teeth including the

humerus, radius and complete manus, the left innominate bone, the femur, tibia and fibula and complete pes; of the axial skeleton is included the atlas, axis and several scattered vertebral centra; also a series of peculiarly coalesced post-sacral or caudal vertebrae.

It is possible that the condition of the caudals found in this specimen was pathological, but they bear a perfectly normal appearance, and point to a unique caudal appendage. Behind the sacrum (which is wanting) we find remains of sub-cylindrical caudal centra, followed by a series of flattened centra which rapidly diminish in size posteriorly; these flattened centra become united together by the adjoining faces, and send out wide flattened transverse processes; but the most peculiar feature is the coalescence of the neural spines and laminae into a long solid ridge which tapers off posteriorly and anteriorly, and renders this portion of the tail absolutely rigid. The only interpretation of this structure seems to be that the proximal portion of the tail was flexible, while the distal half formed a broad solid plate. The humerous suggestion has been made that this appendage supplied *Coryphodon* with a steering apparatus while swimming in the Big Horn Lake; it is impossible to make any serious conjecture as to the purpose which such a tail subserved.

THE FOOT STRUCTURE OF CORYPHODON.

The fore and hind feet of *Coryphodon* have been figured and described by both Marsh and Cope, yet neither of these authors has given an accurate idea of their real structure. Marsh¹ has figured both the manus and pes in the digitigrade position like the feet of the Elephant. In Cope's latest paper upon the Amblypoda² he says of *Coryphodon* and other members of the order, "The feet are always short and *plantigrade*." Elsewhere,³ however, he speaks of the movements of the Coryphodons as resembling those of the Elephant (*i. e.*, digitigrade); Cope's figures correspond with those here published, but fail to represent the actual position of the feet.

¹ *Dinocerata*, p. 184, figs. 150, 151.

² *American Naturalist*, Nov., 1884, p. 1110.

³ *Tertiary Vertebrata*, p. 524.

The fact is that the positions of the fore and hind feet of *Coryphodon* were absolutely different, the *fore foot* was *digitigrade* like that of the Elephant, the *hind foot* was *plantigrade* like that of the Bear.



Fig. 14. *Coryphodon*. Right fore foot, external view, exhibiting Cuneiform, *cn*, resting upon fifth metacarpal, *1'*. (National Museum). One-third natural size.

In other words the carpus was entirely raised from the ground, and the manus rested upon the distal ends of the metacarpals and upon the spreading phalanges, while the calcaneum and tarsus rested directly upon the ground together with the entire plantar surface of the foot. This substantial difference between the advanced state of evolution of the fore foot, and retarded evolution of the hind foot, is of great interest; it is clearly shown in the

accompanying figures.

We may therefore restate the characters of the feet of the *Coryphodon* as follows :

Manus.

Digitigrade. Digits, five.
Scaphoid small.
Lunar enlarged, displaced upon unciform.
Trapezoid small.
Second metacarpal with a large magnum facet.
Third metacarpal with a large unciform facet.

Pes.

Plantigrade. Digits, five.
Fibula rests upon astragalus and calcaneum.
Astragalus displaced upon cuboid.
A tibiale facet upon astragalus.
Mesocuneiform short.
Second metacarpal with a vertical ectocuneiform facet.

Variations.

Cuneiform articulates with fifth metacarpal (see Fig. 14.)

Fibula not articulating with calcaneum.
Tibiale facet upon astragalus reduced.
An 'astragalar foramen' (for flexor communis tendon).

The absence of the fibular facet upon the calcaneum has been observed in a specimen in the Smithsonian collection; also the cuneiform resting upon the fifth metacarpal. These differences,

as well as the variations in the tibiale facet, require fuller investigation.

It will be noted that the manus has many points of functional parallelism with that of the Elephant, especially the enlargement of the lunar. The pes, on the other hand, is much more primitive than that of the Elephant.



Fig. 15. *Coryphodon anax*. Left hind foot, external view of the foot in the natural position One-fourth natural size.

The figure of the pes of *Coryphodon* given by Marsh is somewhat similar to that of *Uintatherium* (*Dinoceras*), and is wholly different from those belonging to *Coryphodon* in the collections we have examined, since the astragalus is represented as *covering the entire upper surface of the cuboid*, and, as above noted, the foot is represented as digitigrade instead of plantigrade; the figure of the manus agrees with those we have examined, except that it is of a higher, narrower type. This author rarely errs in his figures, but in this case it would appear either that the astragalus is wrongly figured, or that these feet belong to some of the Dinocerata.

THE HOMOLOGIES OF THE MOLAR CUSPS IN CORYPHODON.

While leaving to Mr. Earle the full discussion of the evolution of the molars of the Coryphodons, as indicated by the numerous variations in the molar pattern, the homologies of the molar elements with those of *Pantolambda* and of the Perissodactyla may be briefly pointed out. Cope is correct in the interpretation of the lower molar elements, but his interpretation of the upper molar homologies is much more uncertain. We have three means of determining the latter.

1. The comparison with the molars of *Pantolambda*.
2. The actual typical structure of the molars.
3. The vestiges of ancestral structure seen in specific variations.

The molar teeth of *Pantolambda* are tritubercular. There are two external subequal selenoid cusps, the paracone and metacone, separated by a slender median buttress, or mesostyle, with a strong anterior buttress, or parastyle; there are two faintly-marked intermediate tubercles, protoconule and metaconule, and a strong selenoid protocone; there are also anterior and posterior cingula.

The question is how has this selenodont molar been transformed into the lopho-selenodont molar of *Coryphodon*? Cope considers that the anterior crest, or protoloph, of the *Coryphodon* molar represents the union of the protocone and parastyle; that the median external cusp is the greatly reduced paracone, while the postero-external crescent certainly is the paracone. This theory is rendered clear by a study of the *Anchitherium* molar, and it is supported by this comparison, because it is shown in the Equidæ that *where there are two external crescents the protoloph is formed by the union of the protocone with the protoconule and parastyle*.

Another interpretation is the following: that the protoloph of *Coryphodon* represents the union of the protocone with the paracone; that the median external buttress represents the mesostyle; this is supported by the fact that the antero-external cusp in *Coryphodon* is often sub-crescentic as in *C. radians*.

Upon the whole, however, the evidence seems to favor Cope's theory. It is interesting to observe that in examining a large number of *Coryphodon* molars we find traces of the protoconule and metaconule; also faint traces of the mesostyle.

The anterior crest in the Coryphodonts is therefore probably homologous with the anterior crest in the Perissodactyla, especially in the form exhibited in the Equidæ; the posterior crest (or metaloph) of the Perissodactyla is wholly wanting in *Coryphodon*; the external crest (ectoloph) of the Coryphodontia is homologous with the ectoloph or the posterior crest in the Dinocerata.

Order PERISSODACTYLA.

Family TAPIRIDÆ.

Subfamily SYSTEMODONTINÆ.

Genus *Systemodon* Cope.

Dentition : $\frac{3}{1}, \frac{1}{1}, \frac{3}{3}$. Superior dental series continuous. First lower premolar contiguous to canine, followed by narrow diastema. Third and fourth superior premolars with two external cusps and a single internal lobe. Paracone and metacone subequal, conic. Protoloph and metaloph complete. Large third lobe upon third lower molar.

This Eocene Tapir ranks next to *Hyracotherium* in abundance during the Wahsatch period. In this collection there are nearly

fifty specimens which may be referred to it, including numerous lower jaws and several fragmentary skulls. The only skeleton preserved embraces portions of a hind foot which unfortunately is of somewhat doubtful reference, as the associated teeth are only partially preserved. As Cope has shown, there are strong grounds for considering *Systemodon* an ancestor of the Tapirs, and certainly the Tapir stamp in the molar teeth is most striking, as

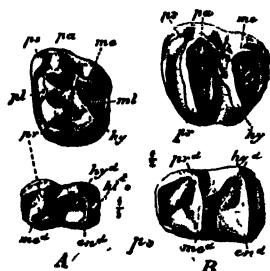


Fig. 16. *Systemodon* and *Tapirus*, first Superior and Inferior Molars. A, *Systemodon semihians*, showing Primary Cusps and Parastyle. B, *Tapirus indicus*, showing complete crests.

shown in the accompanying figures (Figs. 16, 17) yet our opinion must be reserved until we learn the foot structure with certainty.

There are two species, *S. tapirinus* Cope, and *S. semihians* Cope. Our material enables us to distinguish them somewhat more clearly than Cope has done as follows :

S. tapirinus.

Superior.—Internal lobe of second premolar large (Cope).

Intermediate tubercles merged into crests.

External cingulum reduced.

Inferior.—Posterior intermediate cusp (hypoconulid) rudimentary.

Metaconid single.

S. semihians.

Same lobe small (Cope).

Same more distinct ; crests interrupted.

External cingulum complete.

Same cusp, distinct.

Metaconid reduplicate (with metasylid).

The above tables make it evident that *S. semihians* is the more primitive form. In fact it is the most perfect example we know of, of the transition from the primitive bunodont into the pure lophodont type.

Systemodon tapirinus Cope.

This species includes the larger forms, and is much the most abundant.

A crushed skull (No. 149) shows that there was a delicate but prominent sagittal crest. The orbits were not enclosed, but protected posteriorly by a postorbital knob. The premaxillæ extended well upwards upon the side of the face. The nasals were slender, pointed and continued well forward, so that the nostrils were terminal. The lower jaw (No. 234) had a wide angle, and a small slender coronoid process strongly recurved; the condyle is very elevated; it faces upwards and is very slightly convex.

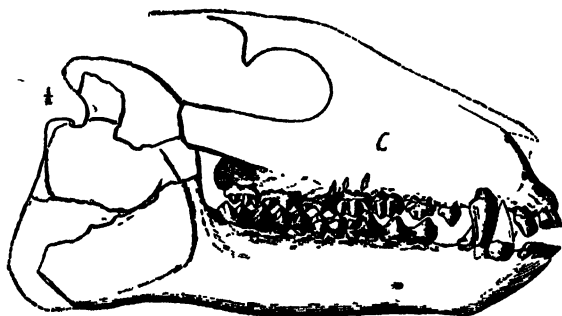


Fig. 17. *Systemodon tapirinus*. View of skull and lower jaw. Composition from two individuals.

The Dentition.—The most novel features of the collection are two specimens (Nos. 144, 150), containing the premaxillæ. The upper and lower incisors have obtusely pointed recurved crowns. The upper canines are large, vertically placed, and with sharply pointed tips; there are two types of lower canines, probably owing to sexual variation, one erect and prominent, the second slightly procumbent and shaped like the first premolar. Cope has noticed the absence of diastemata in the upper series; in the lower series we observe, as a very marked characteristic of the

genus, that the first lower premolar adheres closely to the canine, and is followed by a diastema.

The importance of the *position of the first lower premolar* has not been sufficiently emphasized as *differentiating the different lines of Perissodactyla* we observe (*a*) that in the primitive Tapirine forms the first premolar is placed immediately behind the canine ; (*b*) in the Equine forms, it is in the middle of the diastema between the canine and the second premolar ; (*c*) in the rhinocerotine forms it is always placed behind the diastema close to the second premolar. By this simple law the early representatives of these three lines may be readily distinguished.

The Skeleton.—Many portions of a fragmentary skeleton are associated with a lower jaw and teeth (No. 234), including an astragalus, calcaneum, cuboid, two cuneiforms, several metapodials and proximal phalanges. The tarsus is of a more contracted type than we had anticipated would be found. The astragalus and calcaneum are strikingly like those of *Heptodon* ; the cuboid is, however, much shorter, and the tarsus was therefore proportionally shorter and broader. As in *Heptodon* and *Hyracotherium* there is no lateral displacement, the astragalus having a very narrow contact with the cuboid. There were evidently but three digits with well-marked posterior keels. The phalanges are long and slender ; unfortunately the distal ones are not preserved.

The head of the femur is perfectly round with a decided pit for the round ligament.

Systemodon semihians Cope.

This species includes the more primitive and somewhat smaller forms from the Wahsatch.

The specific characters of the teeth are both progressive and retrogressive. The retention of the posterior intermediate tubercle upon the lower molars is an inheritance from the Condylarthra in which this cusp is invariably present ; the broad external cingulum, the low crests, and the still apparent intermediate tubercles of the upper molars are also primitive marks. The appearance of an accessory tubercle (metastylid) behind the metaconid is, on the other hand, a secondary character ; it seems to be more distinctly developed in this species than in *S. tapirinus*.

2.—*The Wind River Fauna.*

The Wind River collection includes portions of the fore and hind limbs and the complete jaws of *Palæosyops borealis*, also the jaws and nearly complete fore and hind limbs of *Heptodon calciculus*.

Family HELALETIDÆ.

Small perissodactyl mammals extending from the lower Eocene to the lower Miocene. Molars lophodont; paracone and metacone of same size; metacone flattened and placed internally. Ectoloph incomplete, or notched, as in *Tapir*. Protoloph and metaloph complete. Feet tending to monodactylism, lateral digits shorter than median digit. Terminal phalanges compressed.

This family includes *Heptodon* of the Wahsatch and Wind River, *Helaletes* of the Bridger, and a White River (Miocene) genus which cannot be defined because the premolars are unknown.

Genus *Heptodon* Cope.

Dentition: I $\frac{1}{1}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{3}{3}$. Last inferior molar with a small heel. Third and fourth superior premolars with single transverse crests, well-developed external crests and anterior buttress. Digits 4-3.

Heptodon calciculus Cope.

Dentition.—Nine of the twelve upper and lower incisors are preserved and exhibit spatulate to chisel-shaped crowns. The canines are rather slender and finely pointed. The first upper premolar is bifanged and, as in all the rhinocerotiform group, is behind the diastema and close to the second premolar. The latter tooth has a single protocone and a broad internal shelf. The third and fourth premolars exhibit an anterior buttress (parastyle), and two conic external cusps; there is a well-defined anterior crest (protoloph), and an incipient posterior crest (metaloph). The true molars have the conic paracone and flattened metacone which Cope has pointed out as characteristic of this line, the latter has a postero-external cingulum; the crests are sharply defined.

In the lower jaws we find a corresponding diastema behind the canine and a small single-fanged first premolar. This differs from Cope's type (*Tert. Vert.*, p. 656) in which the first premolar is wanting on one side. The second premolar has a narrow posterior talon. The third premolar is less advanced than the corresponding upper tooth, since the anterior and posterior crests are in the most incipient stage. The fourth premolar shows a well-marked metalophid, or anterior crest, and a crested talon. Each of the true molars exhibits a spur extending inwards from the protoconid which represents the primitive line of connection with the paraconid and with a similar fold from the hypoconid to the spurs from the anterior and posterior crests of the rhinocerotiform inferior molar. The third lower molar has a conic third lobe (hypoconulid), which it is very interesting to trace among Bridger successors of the genus.

Lower Jaws.—The lower jaws are beautifully preserved and are remarkable for the slender coronoid process, the elevated condyle, the widely rounded posterior border of the angle. The symphysis extends as far back as a line drawn vertically below the second premolar. The skull is wanting.

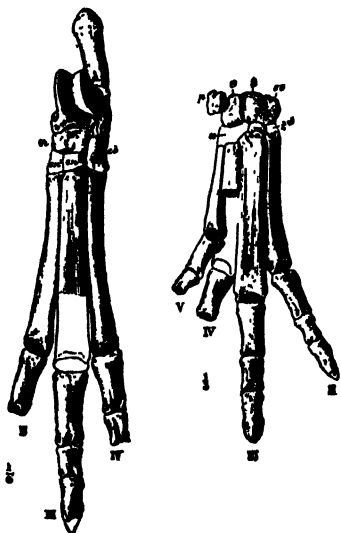


Fig. 18. *Heptodon calciculus*. Left hind foot. Right fore foot. One-third natural size.

Fore Limb.—The limbs as well as the dentition indicate that this individual was not fully mature. The humerus has elevated greater and lesser tuberosities, and a deep, single, bicapital groove; distally, there is a sigmoid radial trochlea, above which is an oval supratrochlear foramen; the internal condyle is slightly more prominent than the external. The ulna and radius are well preserved; they are elongate, slender and arched forwards.

The Manus.—Several of the carpals are preserved; the proportions of the wrist are similar to those in *Hyrachyus*, that is, high and rather narrow. The displacement is similarly advanced; the scaphoid rests widely upon the magnum; the lunar retains a narrow magnum facet and rests mainly upon the unciform; the magnum has an elevated posterior process articulating between the lunar and unciform. The metapodials are of unequal lengths and as a whole shorter than in the Bridger forms, the central metacarpal being $2\frac{5}{8}$ inches in length, while the second and fourth are $\frac{3}{8}$ of an inch shorter; there are sharp keels upon the posterior distal surfaces. The proximal phalanges are much the longest; the distal phalanges are long and much compressed with a deep distal median groove.

The pes is much longer and stouter than the manus, with a high narrow tarsus, three stout digits and elongate phalanges. The calcaneum is high and compressed, with a superior fibular facet; the ental facet is separate, but the ental and sustentacular facets are continuous, as in some species of *Hyrachyus*, with an intermediate groove for a corresponding ridge upon the astragalus. The astragalus has a deep tibial trochlea, a narrow navicular facet, but, as in *Hyrachyus*, it only rests upon the cuboid posteriorly by a narrow facet as in the Equidæ, and not anteriorly as in the Tapirs and Rhinoceroses. The cuboid is elevated and compressed in the centre as in *Hyrachyus*. The navicular is deep, and has a small external contact with the calcaneum, as in the early Hyracotheeriinæ. The external or fourth metatarsal is turned outwards, and has a rather slender oval shaft; the third metatarsal has a stout flattened shaft. The proximal phalanges are long and laterally compressed.

The femur has a small projecting head, an elevated incurved great trochanter, and prominent lesser and third trochanters, with a deep trochanteric fossa; the shaft is recurved, and has a deep antero-posterior section.

The tibia has a double spine, a very long and prominent cnemial crest, and a slight sigmoid or double curvature of the shaft.

RESTORATION.—The limbs and jaws of this young individual indicate that *Heptodon calciculus* was a slender digitigrade perisso-
[October, 1892.]

dactyl, about forty inches long and eighteen inches high (100 x 45 centimeters), with not far from the same dimensions, but of a much more slender type than the Collared Peccary (*Dicotyles tajacu*). The hind limb was much longer and more powerful in all its dimensions than the fore limb, and points to habits of rapid locomotion. In fact, although the tibia and femur are of equal length, the proportions of the limbs and the extreme lateral compression of the hoofs suggest a resemblance to the Cervidæ in locomotion rather than to any of the known Perissodactyla.

The feet are extremely interesting because of the elongation of the median digit, and the shortening of the lateral digits; this character is well shown in the manus, and was probably exhibited in the same degree in the pes, but unfortunately the median digit is incomplete distally in our specimen. In other words, *H. calciculus* exhibits a more marked degree of lateral reduction than the contemporary Wind River Horse, *Hyracotherium venticolum*, which was in a true monodactyl line; there is, however, no compensating enlargement of the magnum.

This specimen of *H. calciculus* was about half as large again as the Wind River *Hyracotherium* restored by Cope, and, compared with later Bridger forms, was one-third smaller than the *Triplopus cubitalis* of the upper Bridger. It is slightly larger than the *Palaplotherium minus* of the Débruge of France.

THE RELATIONSHIPS OF HEPTODON AND HELALETES.—Cope has placed *Heptodon* in the ancestral line of *Hyrachyus*. Osborn has considered it much nearer *Helaletes* Marsh of the Bridger. *Helaletes* was placed by Marsh in the ancestral line of the Tapirs, on account of the presence of a small heel upon the third lower molar, but Osborn¹ has shown that the teeth of *Helaletes* remove it entirely from any relationship to the Tapirs, and has pointed out the probable generic identity of *Desmatotherium* Scott and *Dilophodon* Scott with *Helaletes*.

The discovery of the skeleton of *Heptodon* confirms Osborn's view as to the close relation between *Heptodon* and *Helaletes*, and enables us to form some opinion as to the phylogenetic relationships of these forms. First a word as to nomenclature.

¹ The Mammalia of the Uinta Formation, p. 523.

The synonymy of *Helaletes* is rich, as species variously referred by Leidy, Marsh, Scott and Osborn to *Lophiodon*, *Hyrachyus*, *Desmatotherium* and *Dilophodon* all belong to this genus. It is distinguished from *Hyrachyus*, and marks an advance upon *Heptodon*, by the presence of two internal lobes upon the third and fourth upper premolars. It is further distinguished from *Hyrachyus* and related to *Heptodon* by the variable development of the third lobe upon the last lower molar. Marsh attached considerable importance to this character, in making it a basis of tapirine affinity, but in the six or seven specimens from the Bridger beds in the collections of the Philadelphia Academy and of Princeton, the third lobe (hypoconulid) presents every degree of degeneration from a small distinct cusp, as seen in *H. boops* Marsh, and its synonym *H. (Hyrachyus) nanus* Leidy, to a basal cingulum, as in *H. (Dilophodon) minusculus* Scott. In this genus, therefore, this lobe is merely of specific value, and is rapidly disappearing.

We can now define *Heptodon*, *Helaletes* and *Hyrachyus*, as follows :

Heptodon Cope.

Premolars 4-8. Third and fourth upper premolars with a single crest and single internal lobe. Third lobe of the last lower molar constant. Paracone conic, and metacone flattened, symmetrical, of equal length.

Helaletes Marsh.

Premolars 4. Third and fourth upper premolars with two internal lobes. Third lobe of the last lower molar variable. Paracone conic, and metacone flattened, symmetrical, of equal length.

Hyrachyus Leidy.

Premolars 4. Third and fourth upper premolars with two transverse crests and single internal lobe. M3 without third lobe. Paracone conic, and metacone flattened, asymmetrical, metacone longer than paracone.

Heptodon calciculus agrees closely with *Helaletes boops* in the characters of the tarsus, except that in the latter the two lower facets of the astragalus are not continuous, as observed in Marsh's type individual.

It is clear that *Heptodon* and *Helaletes* represent a line of succession contemporary with that of *Hyrachyus-Triplopus-Hyracodon*, but distinct from it in many characters. The difference is shown in a comparison of the external cusps of the upper molars ; in all the three latter genera they are rhinocerotiform ; that is, the metacone is much longer than the paracone, and forms a continuous ectoloph. In the *Helaletidae*, on the other hand, the external

lobes are of equal size, although the paracone is convex, and the metacone concave, and the ectoloph is interrupted as in the Tapirs.

The nearest relatives of this line are therefore not the American *Hyrachyus* series, but the true *Lophiodon* series of Europe. It is possible that the Helaletidæ will prove to be a branch of the Lophiodontidæ.

Family TITANOTHERIIDÆ.

Subfamily PALÆOSYOPINÆ.

Genus *Palæosyops* Leidy.

It is extremely interesting to find a well-advanced species of this distinctively Middle and Upper Eocene animal in the same horizon (Wind River) with the last representatives of the Coryphodontidæ and Phenacodontidæ, so characteristic of the lower Eocene. *Palæosyops borealis* Cope was an animal only one-fifth smaller than the Brazilian Tapir, *T. americanus*. It was much larger than its contemporaries *Heptodon* and *Hyracotherium*, and equaled in size *Bathyopsis*, the representative of the Dinocerata in the same beds. It was therefore second in size only to *Coryphodon* among the Wind River fauna. This fauna is well known as a mixed fauna of Wahsatch and Bridger types.

Palæosyops borealis Cope.

Superior molars quadrate; external crescents (paracone and metacone) broad and shallow; mesostyle prominent; protoloph faintly marked upon m1 and 2; intermediate tubercles (proto- and metaconules) reduced. Inferior third molars with a small conical third lobe (hypoconulid). First lower premolar spacing the diastema.

This species is represented by several portions of the skeleton of a single individual (No. 296), which fortunately supplement the knowledge obtained from Professor Cope's fragmentary type specimen. The specific identification is based upon the fact that the dental series coincides exactly with the upper molars and premolars of Cope's type; the two lunar bones are also exactly similar. They include a complete lower jaw, two cervicals, three dorsals, and a caudal vertebra, a femur and a humerus, and the greater part of a fore foot.

The jaw is in fine preservation, lacking only the incisors, canines and first premolars. The canines were large and semipro-cumbent ; the first premolar was single rooted, and placed a short space behind the canines ; the second premolar has a sharp laterally compressed crown consisting of an elevated protocone, and distinct but depressed talon ; the third premolar is lower and broader, with a more depressed protocone and a V-shaped talon ; the fourth premolar is submolariform, consisting of two Vs, the metalophid (anterior crest) is well developed with its spur, but the hypolophid (posterior crest) is still wanting. In the first true molars the anterior portion of the crown is higher than the posterior, but in the second molar these regions (trigon and talon) are subequal ; the third molar has a small conical third lobe (hypoconulid) ; the molars increase in size from first to third.

The mandibular rami are characterized by broad, highly convex condyles, slender recurved coronoid processes, deep angles and inferior borders rising rapidly to the narrow, elongate and convex symphyseal region.

The sixth and seventh cervical vertebræ exhibit broad, slightly keeled centra, large arched neural canals, and flat, obliquely placed zygapophysial facets ; the spines are broken, but were evidently quite high ; the seventh cervical is imperforate. The dorsals belong to the anterior portion of the column ; the centra are laterally compressed and trihedral in mid-section ; the zygapophyses are small and nearly horizontal, the spines are slender and have a trihedral section, the metapophyses are elevated and slender ; the parapophyses are not preserved.

The *femur* lacks the head. In comparison with the Bridger species it is distinguished by the great prominence of the third trochanter ; the second trochanter was also prominent ; the great trochanter was slightly below the level of the head ; the shaft has a flattened posterior face as in all the known species of *Palæosyops*.

The *humerus* has a very deep antero-posterior section in the upper portion of the shaft ; the tuberosities are partly broken ; the bicipital groove is very broad ; the deltoid ridge is more prominent than in the Bridger species ; the supinator ridge is normal ; there is a well-marked tuberos projection for the *latissimus*.

simus dorsi; the supratrochlear pit is imperforate; the condyles are subequal.

The Manus.—The structure of the right fore foot is extremely interesting, because of its *functional tridactylism*; (1) the upper



half of the fifth metapodial is preserved; it is decidedly more slender than the second metapodial. Other proofs of functional tridactylism are: (2) the enlarged third metapodial (Mtc. III), which is much longer than the second and fourth; (3) the carpal displacement is extreme, the lunar rests wholly upon the unciform, and has a narrow vertical facet for the magnum; (4) the unciform and magnum are high and narrow. In short this foot is distinctively mesaxonic and functionally tridactyl, whereas the later forms from the Bridger are so far as known paraxonic and functionally tetradactyl; in other

words we find an early species with a more progressive and modified type of foot than the later species, a state of affairs which is decidedly inconvenient for the evolutionist.

AFFINITIES.—According to Earle, who has in press an exhaustive memoir upon the *Palæosyopinae*, the affinities of the upper molars of *P. borealis* are with those of the Bridger species *P. (Telmatotherium) cultridens*, which he considers in the persistent line of succession leading to *Diplacodon* and *Titanotherium*. The incipient tridactyl foot structure of *P. borealis* has affinities with that of *P. (Limnomyops) laticeps* of the Bridger, but the latter is of a more pronounced tetradactyl type. Altogether the discovery of the feet leaves the phyletic position of *P. borealis* more uncertain than before.

V.—GEOLOGICAL AND GEOGRAPHICAL SKETCH OF THE WAHSATCH EXPOSURES IN THE BIG HORN MOUNTAINS.

The valley or basin of the Big Horn lies in almost the extreme northwestern portion of the State of Wyoming, slightly overlapping the line between this State and Montana on the north. Geographically considered it forms an isolated basin enclosed for the most part by high mountain barriers, which for the greater portion of the year are covered with snow. In consequence of this fact, together with the rugged character of the country, travel is at all times difficult, and it is only during the time that the snow is absent that it can be said to be entirely and easily accessible.

In order that the following brief description of its geology may be made more intelligible, I append a short sketch of the geography of the region.

The present geographical boundaries of the basin are very similar to if not identical with those which enclosed the ancient Big Horn Lake, and it is to be seriously doubted if any considerable local disturbances of level have occurred in this region since the beginning of the Wahsatch epoch. The boundary of the basin upon the west is furnished by the main chain of the Rocky Mountains, which here has a direction almost due north and south.

Upon the east, at a distance varying from fifty to seventy-five miles, lies the Big Horn Range almost parallel with the Rockies. Its northern boundary is indicated by the Pryor Mountains, a spur which puts out from the Big Horn to join the main Rocky range. The general trend of this divide is to the northwest, and it is not so well defined nor so high as either the eastern or western boundaries, especially in its northwestern portion.

Upon the south a well-marked but lower range connects the Rockies with the Big Horn Mountains, and although somewhat irregular in direction, has a general trend east and west. This range is cleft about midway by a deep cañon through which the Big Horn River flows and becomes continuous with the Big Horn Range.

To the east of this cañon the mountains are known as the Rattlesnake Range, while on the west they take the name of the Owl Creek Mountains. It is a matter of some interest to note, that while this Rattlesnake-Owl Creek range forms the southern boundary of the Big Horn basin, it also forms the northern boundary of the Wind River basin, which is also the site of an ancient lake which came into existence after the Big Horn Lake was drained.

The basin thus enclosed is about one hundred and fifty miles in length, by from fifty to seventy-five miles in width. It is irregularly oval in form, and has an elevation above sea level of about 3500 feet.

Its drainage is by a number of streams, the principal one of which is the Big Horn River. Above or to the south of the Owl Creek Cañon this stream is known as Big Wind River, but after it passes through the cañon it takes the name of the Big Horn. Its general direction from the Owl Creek cañon to the second gorge, which it has formed in its passage through the Pryor Mountains, is almost due north, and it may be said to lie well to the eastern side of the basin in its passage through it. It finally empties itself into the Yellowstone near Fort Custer, Montana.

Upon the west it receives a number of tributaries, two of which at least are sizable streams at all seasons of the year, and are derived from the melting snows of the high rugged Rockies. The first of these tributaries, beginning upon the north, is Owl Creek, a comparatively small stream, some thirty or forty miles in length, which drains the northern slope of the Owl Creek range, but which goes dry in the latter part of the summer or early fall. Then follow a number of creeks of similar nature whose courses do not extend to the snowy mountains, and which consequently go dry in the summer. They are Cottonwood, Gooseberry, Fifteen-mile, Ten-mile, Five-mile and Elk Creeks, in the order named.

The next tributary is the Gray Bull, a beautiful stream fed by the melting snows from the high mountains to the west. In the spring and early summer it is high, rapid and dangerous, so much so as to interfere materially with our operations in its vicinity during our explorations there. It is said to have a mean fall of

seventy-five feet to the mile from the point where it enters the basin proper, and its waters are used for irrigating purposes by the ranchers who have settled in its fertile valley.

Stinking Water, also fed by the snows of the Rockies, is the next stream on the north, and is somewhat larger than the Gray Bull. It flows with a rapid descent through a cañon for the greater part of its course, and falls into the Big Horn a short distance to the south of the Pryor Gorge. Its name is derived from the distinctly sulphurous odor of the water caused by a number of sulphur springs along its course.

The two tributaries derived from the Big Horn range upon the east are comparatively small and unimportant streams except in spring when there is rapid melting of the snows, and then they are high and turbulent. No Wood, the larger of the two, reaches the Big Horn some fifteen or twenty miles above the mouth of the Gray Bull, while Shell Creek, the other principal tributary from this direction, empties itself into the Big Horn a short distance above Pryon Cañon or the northern gorge of the main river. As is the case upon the west side, there are in addition a number of small streams which are dry for the greater part of the year. The principal one of these is Kirby Creek, which receives the water shed of the northern slopes of the Rattlesnake range, and is the corresponding stream to Owl Creek upon the west.

Another stream which is not a tributary of the Big Horn, but which, properly speaking, belongs to the drainage system of the Big Horn basin, is Clarke's Fork. This stream is about equal in size to Stinking Water, and takes its rise in the high snowy mountains of the main Rocky range to the north of this latter stream. It has formed for itself an independent outlet to the northeast through the low divide which connects the Pryor Mountains with the Rockies, and after gathering a number of tributaries runs parallel with the Big Horn and finally falls into the Yellowstone near the small town of Billings. Its basin, although geographically separate from that of the Big Horn, is geologically a part of it, as I was able to determine after careful examination of its structure.

The general character of the country enclosed within the basin just described may be said, for the most part, to be that of a barren,

sage brush, bad-land desert, very uneven and badly broken by the irregular weathering of the soft Wahsatch sediment with which it was at one time completely filled. The appearance presented by this sediment at the present time is characteristically that of the bad-land scenery so common in the Rocky Mountain region.

THE BIG HORN BASIN.

GEOLOGY.—The geological history of the Big Horn basin is not difficult to decipher, owing to the lack of vegetable growth and the consequent exposure of all the formations entering into its structure. It may be briefly told as follows: Sometime between the close of the Cretaceous epoch and the beginning of the Wahsatch division of the Eocene, the flexure or fold which gave rise to the main Rocky Mountain chain had been elevated, and with it came the subsidiary uplifts which formed the Big Horn range, together with the connecting spurs, the Pryor and Owl Creek mountains. The result of these changes was the formation of an extensive basin walled in by the high mountain barriers already described. There is every reason to believe that the elevation of these mountain ranges was very much more considerable than it is at the present time, since the softer sedimentary rocks have for the most part been removed from their summits, which now exhibit the granitic nucleus of which they are largely composed.

The elevation of these folds took place from the sea-bottom, carrying upwards the older formations which at first formed continuous layers over these mountain ridges, but as the work of erosion and denudation progressed they were removed from the crests of the ranges, and are consequently now represented along the bases of the mountains by sections of their original thickness, tilted up at a considerable angle following the original curve of the fold.

Upon completion of the uplifts the basin became filled with fresh water, and then began the accumulation of that vast layer of sediment which marks the Wahsatch division of the Eocene period.

Gradually the basin was filled with the débris washed down from the neighboring mountain sides, in all probability largely

derived from the older sediments which were now above water, until finally, after the lapse of a long period of years, measured by the accumulation of a mass not less than 2500 feet in thickness, the waters of the lake found an outlet through one or more of the low mountain passes, and at once began the work of wearing down a channel through them. As this channel was worn deeper and deeper it finally reached a point where the waters of the lake were drained off, and the rivers instead of longer depositing their load of sediment in the still waters of the lake, carried them on seaward. With the drainage of the waters of the lake began the process of scoring out the present valleys of the basin, and the carving out of the lake sediment into the remarkable bad-land stretches that are to be seen to-day.

Although I had no means of accurate measurement I was able to determine the approximate thickness of the Wahsatch deposits by the height of surrounding peaks, together with evidence gathered by the county surveys of certain parts of the basin. Just below the bridge at the crossing of the stage road on the south side of Stinking Water stands a bad-land peak (McCulloch's Peak) which is variously stated to be 1500 and 1800 feet high. It is composed entirely of Wahsatch sediment from base to summit, as was determined by the fossils in its vicinity. From this peak to the mouth of Stinking Water is a distance of 25 or 30 miles, and it is said to have a fall of 40 or 50 feet to the mile. It passes through Wahsatch beds all the way, and considering the fact that these beds are horizontal, another 1000 feet must be added to give the entire thickness of the deposit. This does not take into account the wearing away or erosion that has taken place from the summit of the peak, which, during the long period it has been exposed, must have been considerable. At all events, in the absence of exact measurements, I think it entirely within the bounds of probability to say that the thickness of the sediments of the Big Horn Lake, as they are now exposed, is not less than 2500 feet. King¹ gives the aggregate thickness of the Vermillion Creek beds, which contain practically the same fauna as the Big Horn deposits, and are without doubt of the same age, as 5000 feet. In a former

¹ United States Geological Explorations of the Fortieth Parallel, Vol. I, *Systematic Geology*, p. 360.

paper which I published upon the subject,¹ the thicknesses of the Big Horn sediments are given as 4000 feet. This is probably erroneous and was based upon inaccurate computations of the heights of some of the Bad Land Buttes.

Above the bridge at the crossing of Stinking Water the river has cut down to the underlying rocks, and an instructive section is exposed. Here the Wahsatch or Big Horn sediments are seen to lie unconformably upon the older beds. This is shown in many places throughout the basin, and is positive evidence of the fact that there was a distinct break in the deposit of sediment between the older and the newer series. In the Stinking Water section the older formations dip away to the eastward at an angle of 30° or 40°, while the Big Horn strata lie almost if not quite horizontal.

The question of the age of the older rocks is not easy of solution, and in the almost total absence of fossil remains any exact determination is well nigh impossible. As observed upon the northern slopes of the Owl Creek Mountains the succession is as follows: thick masses of limestone resting apparently directly upon the granite, and forming a large part of the crest of the range; this is followed by an intensely red sandstone layer of considerable thickness which Hayden frequently spoke of as the "Jura-Trias red beds." After this comes a succession of layers of bluish clay alternating with beds of compact brown and rusty colored sandstones. In places these sandstones are interbedded with thin strata of coal, some of which is of good quality. At Red Lodge, Montana, these coal veins are of sufficient thickness to admit of extensive mining operations, and it is from this locality that a large part of the coal supply of this region is furnished.

In the mines at Red Lodge some fossil shells have been found, and among them is to be distinguished a large species of the genus *Inoceramus*, which Prof. Whitfield informs me is characteristic of the Dakota division of the Cretaceous. In regard to the continuity of the coal-bearing sandstones and clays at the Red Lodge exposures, with similar exposures in the Big Horn region, I do not think there can be any question; in fact, the same exposures

¹ Proc. Amer. Phil. Soc. Phila., Dec. 1881, p. 139.

are met with on the Big Horn side of the divide but a few miles from Red Lodge on Bear Creek, a tributary of Clarke's Fork, and these beds again appear to be continuous with the coal veins found in so many parts of the basin.

Between these coal-bearing strata and the base of the Wahsatch sediments there intervenes a very thick layer of sandstone, which seems to present the same general lithological characters as the underlying sandstones. An exception to this, however, is found in a section exposed on Stinking Water, where the sandstone immediately underlying the Wahsatch contains faint traces of impure lignite. It may be that these beds are to be referred to the Laramie Cretaceous, but if this is true they are very different from the Laramie exposures to the east of the Big Horn Mountains, with which I am personally familiar. King observes,¹ "Between the uppermost members of the Laramie Cretaceous and the lower beds of the Vermillion Creek Eocene, there is but very slight lithological difference. They are both reddish, friable sandy rocks." This certainly does not agree with the description of the beds underlying the Big Horn sediments, and it is somewhat doubtful if the Laramie is here represented. I was unable to find any strata that would represent the Puerco deposits, and it is more than probable that this formation is also absent in this region.

The Wahsatch sediments are made up entirely of beds of clay and sandstone. The clays vary in color from a light buff to a brick red, although in some places they have a distinctively bluish or slate-colored tint. They contain much lime in the form of small rusty nodules in which the fossils are usually found, and not unfrequently there is much admixture of sand. In other places the sand and clay beds are sharply defined from each other, indicating in all probability rapid changes of the currents of the lake. They are for the most part in an extremely fine state of division, and were undoubtedly derived principally from the erosion of the older Cretaceous and Jurassic formations. The sandstone layers, upon the other hand, are composed of much coarser materials, and very rarely contain the lime nodules seen

¹ Loc. cit., p. 360.

in the clay. They vary in thickness from one to twenty feet, and in some instances even more. When first exposed they are somewhat bluish in color, but owing to the presence of iron they assume a decided rusty color after much weathering.

The fossils are found almost exclusively in the clays, although their occurrence in the sandstones is not unknown. In the clays they are in a majority of instances badly broken and crushed, caused no doubt by the settling and packing of this sediment. In the sandstone, upon the other hand, the bones are generally well preserved, and nearly all of the choice specimens have been derived from this material.

The principal fossil bearing exposures are found in the vicinity of the Gray Bull and Stinking Water, although Buffalo Basin, which is really the upper part of the basin of Fifteen Mile Creek, also contains some good exposures. The exposures without exception face to the northwest, a fact which is explained by the prevailing direction of the storms in the winter and spring.

The basin of Clarke's Fork, although generally regarded as having been filled with deposits of Cretaceous age, is identical in its structure with the Big Horn basin proper. The older formations are the same, and I was able to trace the continuity of the Wahsatch deposits across the high divide, or mesa, from Stinking Water. Not content with this evidence I made careful search for fossils in the exposures of the Clark's Fork basin, and was rewarded by the finding of enough material to settle the age of these beds without further question. The remains are all mammalian, and the species represented are characteristically those of the Wahsatch.

THE WIND RIVER BASIN.

There yet remains to discuss the relationship between the Big Horn and Wind River Lakes. As already indicated, the Wind River basin lies to the south of the Big Horn basin, and is now drained by the same river system, viz. : by the Big Horn and its continuation, the Big Wind River. The Wind River or upper basin was filled with sediment in the same manner as that of the Big Horn, but it is of a later age as is abundantly demonstrated by the fauna it contains.

Now the Owl Creek-Rattlesnake range, as already remarked, formed the southern boundary of the Big Horn Lake and the northern boundary of the Wind River Lake, and the question naturally arises, how can it be that the upper basin is later in age? One would naturally suppose that the upheaval of the Owl Creek Mountains, which formed the southern boundary of the Big Horn Lake, would have also cut off a basin to the south, and that the lower strata of the Wind River deposits would be of the same age as those of the Big Horn. Such, however, is not the case. Every part of the Wind River sediment, from base to summit, belongs to a later geological epoch.

The Wind River Lake was surrounded by high mountain ranges, and its deposits were of great thickness, equal perhaps to that of the Big Horn. How can this be explained?

In trying to make out this problem there was one fact that struck me as very significant, and that was that while all the older formations on the northern slopes of the Owl Creek and Rattlesnake Mountains were in a measure intact and comparatively weathered, on the southern or Wind River side the older rocks had been almost entirely swept away, leaving the granite exposed throughout almost the entire extent of the range. This was not done, moreover, since the close of the Wind River epoch, but prior to the laying down of the Wind River sediments, since they are seen in this immediate section to rest directly upon the granite without any trace whatever of the older rocks.

The presumption is therefore that the Wind River country was above water during the existence of the Big Horn Lake, and that the drainage was in another direction—probably to the east—before the present eastern barrier of the Wind River basin was elevated. This would account for the preservation of the older sediments on the Big Horn side of the Owl Creek Mountains, and their remarkable erosion upon the southern or Wind River side.

Sometime subsequent to the close of the Big Horn period a second elevation took place, which cut off the outlet of the waters of the Wind River region, and a second lake was formed on the site of the present Wind River basin. Just how much time elapsed between these changes is difficult to determine, but judging from the relations of their respective faunæ it could not have been very great.

When the Wind River Lake was finally filled its waters found an outlet to the north, excavating the remarkable gorge now known as the Wind River Cañon. It is through this channel that the drainage has since found an outlet seawards.

SUMMARY.

The following are the main features of my observations :

1. That the Puerco and Laramie do not underlie the Wahsatch in the Big Horn basin, but the strata rest upon older secondary rocks.
2. That the thickness of the Wahsatch in this basin is about 2500 feet, or considerably less than the 4000 assigned to the same strata in the Vermillion Creek exposures.
3. That the Clarke's Fork basin, although geographically separate, is in age and deposition identical with the Big Horn basin.
4. That the Wind River beds are absolutely distinct from the Big Horn Wahsatch, and belong to a succeeding deposition.

VI.—NARRATIVE OF EXPEDITION OF 1891.

The expedition into the Big Horn region of Wyoming was outfitted at Red Lodge, Montana, a small mining town at the terminus of the Rock Fork Railroad, which is a side branch of the main line of the Northern Pacific. The outfit consisted of wagon and team, riding horses and other necessary equipments for such a trip. One assistant was employed, Mr. M. L. Jones, of Red Lodge, who not only acted as teamster and cook, but also rendered much assistance in collecting.

Our immediate destination, after leaving Red Lodge, was the extensive exposures lying to the south of the Gray Bull River in the vicinity of its junction with the Big Horn, some hundred and twenty-five miles from the point of starting. After crossing Stinking Water, we turned off the main stage road between Matutau and Red Lodge, and traveled east to the Old Bridge trail. In this region we met with a number of Wahsatch exposures, most of which are entirely barren. The few specimens we secured were very fragmentary.

Within less than a week we reached the Gray Bull River, but found it impassable on account of high water. While waiting for it to fall we examined the exposures upon the divide between the Gray Bull and Dry Creek to the north, and met with considerable success.

On the south side of the Gray Bull from near its mouth to a point twenty miles up the river are to be found the best exposures of the Big Horn Wahsatch. They extend from near the river south for a great distance, and while fossils cannot be said to be abundant at any point, yet careful search through these extensive exposures has resulted in a fairly good collection. It was in this locality therefore that the greater part of the summer was spent.

The examination of the beds within easy reach of the river was not difficult and collecting was comparatively easy, but when we came to extend our field to the more distant bad-lands, we encountered much greater difficulties. Scarcity of water was the greatest obstacle with which we had to contend, and it was only by dint of hard labor and much perseverance that we were able to accomplish the examination of these outlying sections.

Experience of former expeditions into this locality had taught me the necessity of being properly equipped for this emergency, and we, accordingly provided ourselves with suitable casks for transporting water on the back of a pack-horse. Our usual method was to establish dry camps in the midst of the bad-lands where one man with a supply of fifteen or twenty gallons of water could subsist for a week or ten days without difficulty. At the expiration of this time he would have completed the examination of the exposures in his immediate vicinity, when his assistant would bring a fresh supply and move his camp into another place. In this way weeks were spent in a search for fossils in regions entirely destitute of water, and it may be said in passing, that some of our best specimens were secured in these places.

Generally the fossils were found washed out of the sediments so that little excavating was necessary. In some instances, however, they were found in the rock. For the most part ordinary methods of collecting were practiced, viz. : gathering up all the pieces and packing them properly for shipment, but the collection of some of the fossils deserves especial mention in view of the somewhat

novel methods employed. Upon one occasion, while camped alone in the bad-lands, about fifteen miles from the main outfit, I came upon a few teeth which I at once recognized to be of unusual interest. They had washed out of a low sandstone bluff, leaving the point of the lower jaw still remaining. Search as carefully as I would I could not find more than the merest handful of fragments of bone and broken teeth, which were very unsatisfactory indeed. In washing out the fragments that had been deposited upon a level surface some twenty or thirty feet square, I was led to infer that the remaining fragments of perhaps the entire skull were covered up in the loose dirt. Acting upon this I carefully scraped up all the dirt and packed much of it out to the river in sacks on the back of a horse. Later we found a tolerably passable route for our wagon, and hauled it all to the river where we carefully washed it after the manner of the placer miner. In this manner, laborious as it was, we recovered almost the entire upper and lower maxillæ of the rare and hitherto little known genus *Palæonictis*. After cementing the fragments together we find that the entire dentition is present, together with some important parts of the skull. In this way, too, we recovered much of the skeleton of another Creodont (*Oxyæna lupina*), including the carpus and most of the foot bones, which have been hitherto entirely unknown. This simply serves to illustrate the care and energy that are often necessary on the part of the collector if he would meet with even an ordinary measure of success in this region, where anything like complete skeletons are very rare indeed.

Our first side trip was made into the bad-land exposures lying between Gray Bull and Stinking Water in the vicinity of the mouth of the latter stream. In so doing we passed over the old Bridger trail and met with many exposures, most of which were barren. Owing to the extreme scarcity of water, however, and the great distance we would have been compelled to carry it, we did not explore these exposures as thoroughly as we would have done had the circumstances been more favorable.

Our next trip was into the Buffalo basin which, as I have already said, is the upper or western part of the valley of Fifteen Mile Creek. These exposures pertain to a much higher level than those

of either the Gray Bull or Stinking Water, being probably within 800 or 1000 feet of the top of the entire sedimentary mass. On this account we have kept all collections from this horizon separate from the rest.

Although these beds are mostly barren, we were able to secure a fair collection from them by dint of hard labor. The water and grass were extremely poor at the time of our visit, and it was with great difficulty that we could keep control of our animals. The water was, in fact, but little better than thin alkali mud, and in many instances literally swarmed with animal and vegetable life. Our best finds in these beds were some very good specimens of the peculiar genus *Anacodon*, together with those of Lemuroids, Rodents and Coryphodons.

Our last trip was into the Wind River basin to the south, and although we had comparatively little time at our disposal, and much traveling to do in order to reach this locality, we successfully accomplished the task, and returned after an absence of twenty days with some important specimens from this horizon to reward us for our efforts. The more or less complete skeletons of *Heptodon calciculus* and *Palæosyops borealis* were among the principal finds of this trip.

It was the work of but a few days to get our collections together, pack them properly and return to the point of starting, where we arrived after an absence in the bad-lands of nearly four months.

Article XII.—REVISION OF THE SPECIES OF CORYPHODON.

By CHARLES EARLE.

The recent expedition sent out by the American Museum of Natural History to the Bad Lands of the Wahsatch formation of Wyoming was successful in procuring some valuable *Coryphodon* material.

Through the kindness of Dr. H. F. Osborn, Curator, the entire collection has been placed in my hands for identification and study. In taking up the *Coryphodontidæ*, I am surprised by the great number of species which have been proposed, and I find upon studying and comparing the types that a great reduction in the number of species should be made.

Prof. Cope, with his usual liberality, has kindly allowed me to study his whole collection of *Coryphodon* material, therefore I am now prepared to revise the species approximately, and to give a fairly accurate diagnosis of each. Unfortunately nearly all the American material of *Coryphodon* has been found scattered, so that it is almost impossible to say what parts of the skeletons of the different individuals should be associated with each other.

The collection in the American Museum contains, among other specimens, the greater part of the skeleton of *Coryphodon anax* (= *Bathmodon pachypus* Cope), although there are no teeth associated with this specimen. There is also a very valuable specimen of *C. obliquus*. This latter is of importance, as it represents one individual, and contains the upper and lower dentition nearly complete.

Since Prof. Cope's original discovery¹ of the occurrence of the genus *Coryphodon* in America, he has described four new genera of the *Coryphodontidæ* from this country.

¹ Proc. Am. Phil. Soc., 1872, p. 417.

I am especially doubtful as to the validity of the genus *Bathmodon*, and shall consider it in this paper as a synonym of *Coryphodon*. The character upon which this genus was based—namely, the presence of a tibiale facet upon the astragalus, will, I believe, be found not to be confined alone to this genus of the Coryphodontidæ, but will prove to be one of the ordinal characters of the Amblypoda in general. The presence of a tibiale facet upon the astragalus is the general rule among the other members of the Amblypoda. Marsh¹ has noticed the presence of this facet in the Dinocerata. He also adds, "The astragalus in *Coryphodon* is very similar in form to that in the Dinocerata, but is shorter. It has essentially the same articular faces, and the facet for the tibiale is equally well marked."² Prof. Cope³ has also pointed out the existence of a tibiale facet in the astragalus of the genus *Pantolambda*.

We see from the above that in all the genera of the Amblypoda, of which we possess good examples of the astragali, there is the common character of an internal tibiale facet.

The material referable to the tarsi of *Coryphodon* and allied genera in Prof. Cope's collection is very limited. He⁴ has described a species of *Coryphodon*, named *C. latipes*; associated with the skeleton, upon which this species is based, are two astragali. These are the only astragali in Prof. Cope's collection, which I find have been referred to the genus *Coryphodon* by him.

The two astragali above mentioned are much worn and rounded off, and as they are associated with other parts of a skeleton which shows decidedly juvenile characters, I believe that the whole skeleton belongs to an immature specimen of *Coryphodon*, in which it is impossible to form a conjecture as to the presence or absence of the tibiale facet.

I do not retain the genus *Metalophodon* Cope as a distinct genus, for the reason that all stages of transition occur, in which the posterior limb of the external crescent of the second superior molar is well developed, down to that in which the crest has

¹ Monograph of the Dinocerata, pp. 146 and 148.

² This description is not confirmed by Osborn.

³ Tertiary Vertebrata, p. 612.

⁴ Proc. Am. Phil. Soc., 1873, p. 33.

TABLE SHOWING ALL THE PROPOSED AMERICAN SPECIES OF CORYPHODON AND RELATED GENERA, WITH THEIR ORIGINAL NAMES, NATURE OF TYPE, AND LOCALITY.

NAME.	DATE.	TYPE.	FIGURE.	LOCALITY.
1. Bathmodon radians <i>Cope</i>	Proc. Am. Phil. Soc., Feb. 16, 1872, p. 417.	Sup. m. 2 & 3 with skeleton.	Tert'y Ver., pls. 45-57.	Evanston, Wy.
2. Bathmodon semicinctus <i>Cope</i> ...	" " " "	Teeth.....	" " " "	" "
3. Metalophodon armatus <i>Cope</i>	" " 1872, p. 542.....	Superior molars.....	Tert'y Ver., pl. 49....	Black Butte, "
4. Metalophodon testis <i>Cope</i>	" " 1881, p. 175.....	" " " ".....	" " pl. 44 a....	Big Horn.
5. Bathmodon latipes <i>Cope</i>	" " 1873, p. 33.....	Skeleton.....	" " pl. 48.....	Evanston, Wy.
6. Bathmodon elephantopus <i>Cope</i> ..	Rep. Vert. Fos. N. M., Wheeler, 1874, p. 10.	Last sup. and inf. m. 3...	Pal. of N. M., pls. 50-54	New Mexico.
7. Bathmodon sinus <i>Cope</i>	" " " " p. 8.	Inferior molars.....	" " pl. 55.....	" "
8. Bathmodon lomas <i>Cope</i>	" " " " p. 9.	Inferior molar 3.....	" " pl. 54.....	" "
9. Bathmodon molestus <i>Cope</i>	" " " " " "	Sup. and inf. molars.....	" " pls. 56-57.	" "
10. Bathmodon latidens <i>Cope</i>	Syst. Cat. Vert. N. M., 1875, p. 29.....	Jaw with teeth.....	" " pls. 48-50.	" "
11. Bathmodon cuspidatus <i>Cope</i>	" " " " p. 30.....	Inferior molar 3.....	" " pl. 46.....	" "
12. Coryphodon hamatus <i>Marsh</i> ...	Am. Jour. Sci. & Arts, 1876, p. 426.....	Sup. and inf. molars.....	Mon. of Dinocerata, p. 52.	Wyoming.
13. Coryphodon obliquus <i>Cope</i>	Pal. of New Mexico, Wheeler, 1877, p. 207.	" " " ".....	Vert. Pal. N. M., pl. 47.	New Mexico.
14. Coryphodon lobatus <i>Cope</i>	" " " " p. 209.	" " " ".....	" " pl. 46.	" "
15. Coryphodon repandus <i>Cope</i>	Proc. Am. Phil. Soc., 1881, p. 171.....	Inferior m. 2 and 3.....	Tertiary Vert., pl. 44c.	Big Horn.
16. Coryphodon curvirostris <i>Cope</i> ...	" " " " p. 172.....	Sup. m. 2 & mand. with teeth.	" " pl. 44c.	" "
17. Coryphodon marginatus <i>Cope</i> ...	" " " " p. 174.....	Superior molar 3.....	" " pl. 44e.	" "
18. Coryphodon anax <i>Cope</i>	" " 1881 (1882), p. 168..	Sup. and inf. molars.....	" " pls. 44a-e.	" "
19. Bathmodon pachypus <i>Cope</i>	Proc. Acad. Nat. Sci. Phila., 1882, p. 204.	Skeleton.....	" " pls. 44d-g.	" "
20. Mantecodon subquadratus <i>Cope</i> ..	Proc. Am. Phil. Soc., Dec. 16, 1881.....	Last sup. m. with incisors.	" " pl. 44a.	" "
21. Ectacodon cinctus <i>Cope</i>	" " " " p. 167..	Superior molars.....	" " " "	" "

nearly disappeared.¹ In fact the absence or presence of the posterior limb of the crescent in *Coryphodon* is largely dependent upon the amount of abrasion, for as the tooth becomes more worn it involves the posterior limb of the crescent. This abrasion first affects the external portion of the posterior limb, and further wear will bring it into continuity with the internal apex of the crescent.

VARIATIONS AND HOMOLOGIES OF THE MOLAR TEETH.

Before taking up the descriptive part of this paper, I propose to treat some of the variations of the teeth and of the homologies of the molar cusps.

I have found it extremely difficult to define the limits of the specific groups in this genus, as in so many cases the species run into each other by insensible gradations. I have for that reason decided to reduce the species described to about half the number originally proposed.

The canine teeth show a great amount of variation as to size, and this is probably due partly to age and sex. The inferior canines associated with the type of *C.anax* are very much larger than those of *C. radians*, although the inferior molar series of these two species are nearly of the same size.

In no case have I been able to find two series of teeth of the same species which are even closely similar in size, etc. They always vary in their dimensions and in the characters of the crest of the last superior and inferior molars. For example, in *C. elephantopus*, Cope mentions the fact that in his specimen the last superior molar exhibits traces of the posterior limb to the crescent, whereas in the specimen in the American Museum collection this tooth is without this rudimentary limb, although in all the other characters our series of teeth correspond exactly to those of the type in the Cope collection. This same variation exists in *C. radians*, as already mentioned; now if we are to interpret all these variations as specific, the list of species in this genus would increase indefinitely. I therefore, in limiting the species, have summed up the characters in all cases when comparing related species, and have not considered slight variations as specific.

¹ See Marsh's figures of *Coryphodon*, Monograph of the Dinocerata, p. 58.

The structure of the crescent in the second superior molar is an extremely variable character, and when we compare the series of species from *C. radians* through *C. elephantopus* to *C. hamatus*, I am sure we can find no generic characters between them, but must recognize the fact that we are here dealing with a phyletic series in which, in the first-named species, we have the crescent well developed, down to that where the posterior limb is completely lost. In *C. radians* the form of the second superior molar and characters of the external crescent appear to be fairly constant, but in the last upper tooth of the superior series the case is different. There is, however, one character of this tooth which appears to be diagnostic of the species, and that is the relations of the external portion of the anterior crest to the basal part of the molar; in this species the anterior crest divides into two branches running externally to the base of the crown. The fine series of teeth (No. 274) in the American Museum collection exhibits this character very well, although the form of the last superior molar is different from the type specimen.

The great variation shown by the facets of the astragalus and calcaneum will be described later, and I believe it is not possible at present to diagnose any species upon these variable characters.

The variations shown by the long bones of the skeleton are many; they chiefly affect their length and the size of their distal and proximal extremities.

HOMOLOGIES OF THE CUSPS.—The homologies of the dental elements of the superior true molars of the Coryphodontidæ are not determined without considerable difficulty, and only by a comparison of the teeth of *Coryphodon* with the most primitive member of this group, namely *Pantolambda*, are we enabled to understand the structure of the type of molar found in *Coryphodon*. Prof. Cope¹ has studied the question of the homologies of the cusps in the Coryphodontidæ, and it appears to me that his conclusions are satisfactory. He finds that the tritubercular form of superior molar, as found in *Pantolambda*, was the probable starting point for the *Coryphodon* molar. In the former genus (Fig. 2 A) both external crescents are well developed, and there is a prominent parastyle or antero-external buttress.

¹ American Naturalist, 1884-85, pp. 1115 and 1195.

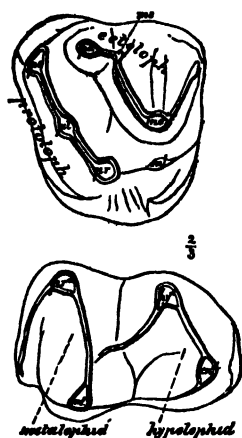


Fig. 1. The Morphology of an upper and lower Molar of *Coryphodon*. *pa*, paracone; *me*, metacone; *pr*, protocone; *ps*, parastyle; *ms*, mesostyle; *pl*, protoconule; *ml*, metaconule; *pyd*, protoconid; *kyd*, hypoconid; *end*, entoconid.

In some of the species of *Coryphodon* we find, as the external elements of the crown, on the first and second superior molar, a strongly-developed posterior crescent, and connected with the anterior limb of the crescent, a prominent conical cusp (Fig. 1, *pa*).

The question is: what is the homologue of this cusp in *Pantolambda* and other Ungulates? Prof. Cope believes that this cusp is the sole representative of the anterior crescent of *Pantolambda*. On the second and last superior molars of *Coryphodon* the rudimentary anterior crescent is reduced to a cusp; but on the first molar this cusp is much elongated, and forms a short crest.

The *Coryphodon* molar still retains the large parastyle which is so characteristic of the teeth of *Pantolambda*. The mesostyle

(Fig. 1, *ms*) in *Coryphodon* is only slightly developed, and is more prominent on the second superior molar than on any of the others.

The anterior transverse crest or protoloph in *Coryphodon* has probably been developed from the crest running externally from the protocone of *Pantolambda*.

It is very interesting to observe that in some species of *Coryphodon* the protoloph is enlarged at its middle, this enlargement being the homologue of the protoconule. Traces are also present of the metaconule.

The most primitive condition of the last inferior molar in *Coryphodon* is probably where the heel has a straight posterior border, for this is the condition in *Pantolambda*.

In *Coryphodon obliquus* we see the origin of the internal ridge or tubercle, which, as it increases in size, forces the entoconid to take the place of the fifth lobe of other forms, but the last inferior molar of *Coryphodon* has no element homologous with the hypoconulid or fifth lobe of the true Lophodonts.

The *Coryphodonanax* type shows the greatest specialization in the structure of the heel of the last inferior molar. In this species the three lobes of the heel are very large and equal in size.

It is interesting to note that the *Pantolambda-Coryphodon* line was first introduced by the tritubercular type of molar; later, however, in the Wahsatch period this line probably divided into two sublimes, one leading to *Manteodon*, the other to *Coryphodon*. The first subline is characterized by the quadritubercular form of molar; in the last, however, the tritubercular type persisted.

Revised Table of Species and Synonyms.

SPECIES.	SYNONYMS.
1. <i>Coryphodon radians</i>	= <i>C. repandus</i> .
2. <i>Coryphodon testis</i>	= <i>Metalophodon testis</i> .
3. <i>Coryphodon elephantopus</i>	= <i>C. simus</i> , <i>C. molestus</i> , <i>B. lomas</i> ,
4. <i>Coryphodon cuspidatus</i> .	(<i>C. latidens</i> ?), <i>C. hamatus</i> ?
5. (<i>Coryphodon hamatus</i> .)	
6. <i>Coryphodon obliquus</i> .	
7. <i>Coryphodon curvicristis</i> .	
8. <i>Coryphodon anax</i>	= <i>Bathmodon pachypus</i> , <i>Coryphodon lobatus</i> .
9. <i>Manteodon subquadratus</i> .	
10. <i>Ectacodon cinctus</i> .	

Coryphodon Owen.

SYN.—*Bathmodon* Cope. *Metalophodon* Cope.

Premolars simpler than molars. Superior premolars, except first, consisting of an external and an internal crescent. Inferior premolars with only one crescent. Last inferior premolar much simpler than first true molar. Superior molars tritubercular, antero-external cone (parastyle) connected with protocone by a strong crest. First superior molar with well-developed postero-external crescent, second superior molar with crescent complete or incomplete. Last superior molar with crescent reduced to a posterior crest, Mesostyle well marked. Inferior true molars consisting of two crescents with anterior limb of each much reduced; trigonid raised above heel. Elements of heel of last inferior molar, entoconid and hypoconid; no cusp homologous with hypoconulid. No scapho-magnum articulation. Astragalo-cuboid contact large. Astragalus flat, with internal facet for tibiale.

Synoptical Table of the Genera and Species of Coryphodontidae.

- A. Last superior molar with postero-external crescent complete. Internal cones two (hypocone developed) *Manteodon*.
 Hypocone smaller than protocone. *M. subquadratus*.
 B. Last superior molar with postero-external crescent lacking posterior limb. Internal cones one (hypocone wanting, or rudimentary)..... *Coryphodon*.

- I. Second superior molar with external crescent complete.
 - a. Heel of last inferior molar bilobate.
 1. Paracone and posterior crest of last superior molar in a straight line (type)..... *C. radians*.
 2. Paracone and posterior crest of last superior molar forming a right angle..... *C. elephantopus*.
 - b. Heel unknown. Last superior molar with postero-external cusp.
C. (Ectacodon) cinctus.
 - c. Heel of last inferior molar trilobate.
 1. Accessory tubercle in posterior valley a cusp (bunoid).
 Size small..... *C. cuspidatus*.
 2. Accessory tubercle in posterior valley a lobe (lophoid).
 Size large. Sup. m. 3 subtriangular..... *C. anax*.
 Size small. Sup. m. 3 oval..... *C. obliquus*.
 - d. Heel of last inferior molar forming a crest (hypoconid and entoconid continuous)..... *C. curvicastris*.
- II. Second superior molar with external crescent incomplete.
 - e. Heel of last inferior molar unknown. Sup. m. 2 with posterior limb of crescent reduced..... *C. (Metalophodon) testis*.
 - f. Heel of last inferior molar bilobate. Sup. m. 2 with posterior limb of crescent wanting..... *C. hamatus*.

***Coryphodon radians* Cope.**

SYN.—*Coryphodon repandus* Cope.

Last superior molar subtriangular in outline, external termination of anterior crest generally in continuity by two ridges with basal portion of crown; postero-external crest oblique and connected with posterior cingulum by a sharp ridge (type). Last inferior molar with heel bilobate.

The type specimen of *C. radians* (Fig. 2, *B*, p. 159) consists of the last two superior molars with upper premolars, and lastly of an astragalus, femur, and other fragments of the skeleton.

The specimens in Prof. Cope's collection upon which he based his *C. repandus* are two superior molars and a portion of a jaw bearing the last two molars, all from the same individual. The measurement and character of these teeth are almost identical with the type specimen of *C. radians*, and for that reason I believe they should be referred to that species. The difference in character of the posterior crest of the last superior molar in the two types is largely due to the condition of wear, and I think are not specific.

Coryphodon radians was the first American species of this genus described. Prof. Cope¹ at the time of the discovery

¹ Proc. Am. Phil. Soc., 1872, p. 417.

of this species referred it to a new genus *Bathmodon*. Later he¹ recognized the fact that *Bathmodon* was identical with the European genus *Coryphodon*, and in his subsequent work on the 'Extinct Vertebrata of New Mexico' (1877), described this species and many others under the name of *Coryphodon*. In his 'Tertiary Vertebrata'² Prof. Cope again separated *Bathmodon* from *Coryphodon*, basing the differential characters of the genus upon the presence of an internal facet on the astragalus for the tibiale. As already mentioned, I cannot recognize this character as generic, but believe that it is common to the order Amblypoda. The original material from which *C. radians* was described came from Evanston, Wyoming. Prof. Cope states that later he procured a mandible from the same locality, which he supposed belonged to this species. I believe he is correct in associating the form of last inferior molar with a bilobate heel with the type of *C. radians*. Another reason for supposing this association to be correct, is the fact that the type specimen of *C. repandus* includes both upper and lower teeth from the same individual; also in this species the heel of the last inferior molar has a straight posterior border. If I am correct in supposing that *C. repandus* is the same species as *C. radians*, then the posterior limb of the crescent of the last superior molar is a variable character, as the type specimen of *C. repandus* shows none.

I consider also that *C. radians* and *C. anax* are very closely related species, and that *C. anax* may not be specifically distinct; this is shown by the fact that the inferior molar series of the two species are nearly of the same size. The internal tubercle, which is so characteristic of the last inferior molar of *C. anax*, is quite variable in size and position. There are three jaws in Prof. Cope's collection, two of which he refers to *C. anax*; in one (No. 2) the dimensions of the dental series are less than in the type of *C. radians*, and in this jaw the internal tubercle of the last inferior molar is not as much separated from the median tubercle as in the type specimen. The last upper molar of the type of *C. radians*, however, is smaller than that of *C. anax*.

¹ Pal. Bull., No. 21, April 11, 1876, p. 2.

² Tertiary Vertebrata, 1884, p. 544.

Measurements of Jaws.

	<i>C. anax</i> , No. 1.	<i>C. anax</i> , No. 2.	<i>C. radians</i> .
	M.	M.	M.
Entire length of jaw.....	.420	.370	
Molar series, total.....	.195	.170	.195
Depth of jaw below m. 2.....	.085	.070	.070
Length inferior m. 3.....	.044	....	.043

The astragalus which Prof. Cope has associated with the type of *C. radians* is much smaller than that of *B. pachypus*, and it is strange that such is the case, as the teeth of *C. radians*, at least the lower ones, are nearly as large as those of *C. anax* (= *B. pachypus*). The astragalus of *C. radians* is nearly square in its dimensions; the tibiale facet is very large, and placed at right angles to the navicular face of the bone. This facet is separated by a notch from the superior face of the astragalus, although I believe this to be a variable character. Also in this astragalus the groove between the sustentacular and ectal facets is continued posteriorly into a foramen which opens above. This is probably another variable character, and will be more fully considered under the head of *C. anax*.

A few species of *Coryphodon* have been recorded from the Wind River. Prof. Cope¹ includes two species from this formation, namely: *C. radians* and *C. cuspidatus*. Among the collection of specimens brought from the Wind River by Dr. Wortman, there are fragments of a skeleton of a species of *Coryphodon*, including a few teeth fairly well preserved. These teeth are of the last of the lower series, and compare nearly in size and character with those of *C. radians*. I therefore provisionally refer them to this species.

Coryphodon testis Cope.

SYN.—*Metulophodon testis* Cope.

Second superior molar much larger than the last; posterior limb of crescent reduced to an external cusp. Last upper molar oval in outline with posterior crest straight.

¹ On the Vertebrata of the Wind River Eocene Beds of Wyoming. Bull. U. S. Geol. Surv., 1881, p. 183.

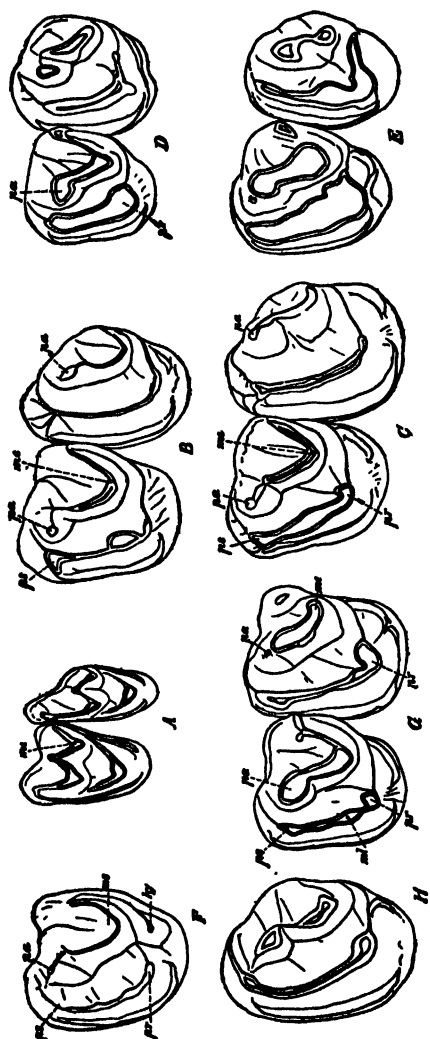


FIG. 2. Comparative view of second and third upper molars of *Coryphodon*. A, *Pantolambda*, $\frac{1}{2}$ natural size. All others $\frac{1}{2}$ natural size. B, *C. radians*, type. C, *C. radians*. D, *C. elephantopus*. E, *C. testis*, type. F, *Manitodon subquadratus*, type. G, *Ectacodon cinctus*, type. H, *C. anas*, type.

The type of *C. testis* is a beautiful series of the maxillary teeth of both sides in Prof. Cope's collection (Fig. 2, E). Prof. Cope¹ originally described the genus *Metalophodon* from two series of teeth,² one mature, the other a series of milk teeth, which were found in the same locality, although from different skulls. 'These teeth are in such a poor state of preservation, and as the last two upper molars of the mature specimen are of the same size and character, I cannot consider them as good types. In the *Coryphodontidæ* the second superior molar always differs widely in form and characters from the last, and I have yet to see an exception to this rule.

The exceedingly fine type specimen of *C. testis* has the second superior molar much larger, and every way different in character from the last. The posterior limb of the crescent in this molar has only its external portion worn, although further

¹ Proc. Am. Phil. Soc., 1872, p. 542.

² Tertiary Vertebrata, pl. xlix.

abrasion would probably have brought the whole limb in continuity internally with the apex of the crescent. The last superior molar of this species is oval in outline, with no postero-external enlargement such as is characteristic of the *C. elephantopus*.

Coryphodon elephantopus Cope.

SYN.—*C. simus*, *C. molestus*, (*C. latidens*?), *B. lomas*.

Last superior molar with postero-external portion prolonged beyond crest ; external part of posterior crest forming a right angle with the internal.

The type of *C. elephantopus* described by Prof. Cope¹ is a last superior and inferior molar. Later in his 'Extinct Vertebrata of New Mexico,' he described the finely-preserved skull with teeth which is figured in this work (Fig. 2, *D*).

I refer specimen No. 275 in the American Museum collection to this species, although its teeth differ in some of their characters from those described by Prof. Cope ; this difference consisting in the fact that the last superior molar shows no trace of a posterior limb to the external crescent ; otherwise the measurements and characters of the teeth are identical. I have shown elsewhere that this character is a variable one in *C. radians*, and will not suffice for specific definition.

Prof. Cope recognizes three other species of *Coryphodon* which are closely related to *C. elephantopus* ; these are the *C. simus*, *C. molestus* and *C. latidens*.

The material pertaining to *C. molestus* is abundantly represented in Prof. Cope's collection, and numerous figures are given in the work above cited.

The type of *C. simus* is a lower jaw with teeth. In this specimen the last inferior molar is preserved, whereas in the type of the lower jaw of *C. elephantopus* this tooth is wanting. The teeth of *C. simus* are slightly smaller than those of *C. elephantopus*, otherwise I see no distinction between them.

The *C. latidens* was established upon the well-preserved mandible with teeth figured in the 'Extinct Vertebrata of New Mexico.' In this specimen the last inferior molar is also preserved, and

¹ Report of Vert. Fossils N. M., Wheeler, 1874, p. 20.

² Vertebrate Paleontology of New Mexico, Wheeler, 1877, pl. xlviii.

differs quite radically in form from that of the type of *C. simus*. The measurements of the lower teeth of *C. latidens* correspond exactly with the superior molars of *C. elephantopus*, and for that reason I do not give it specific rank, although further material may show that *C. latidens* is a good species.

There is another reason for referring *C. latidens* to *C. elephantopus*. In the former species the last inferior molar of the type specimen has a straight heel, with no trace of the posterior enlargement which is so characteristic of the *C. anax* and the more specialized species. Now the square form of the last superior molar of *C. elephantopus* should, I believe, be associated, as in *C. radians*, with a last inferior molar which has a bilobate heel. I have positive proof from a specimen in the American Museum collection that the oval form of last superior molar is associated with the trilobate heel.

I have labored under the disadvantage of not being able to study any of the types of *Coryphodon* from New Mexico, which have been described by Prof. Cope. Accordingly some of my conclusions as to the synonyms of the species may be incorrect; however, I can hardly appreciate the specific distinctions, made by Prof. Cope, between many of the Wahsatch species from New Mexico.

***Coryphodon cuspidatus* Cope.**

Last inferior molar with a prominent conical tubercle on internal side of heel.

This is a smaller species of the genus, and closely related to *C. obliquus*; it was established upon a posterior portion of a last inferior molar from New Mexico.

The tubercles and ridges on the last inferior molar of this species of *Coryphodon* are exceedingly variable characters. In the collection of the American Museum there is a series of lower molars of *C. radians*, and on the external side of each last molar there is a prominent tubercle between the lobes. I should hardly venture to refer this specimen to a new species based upon this character, and believe it to be merely a variation from the typical form of molar found in *C. radians*.

[October, 1892.]

Coryphodon hamatus Marsh.

Superior true molars broad and short as in *C. elephantopus*. Second superior molar with posterior limb of crescent absent.

I describe the characters of this species from the figure of its dentition given by Marsh.¹ If this be correct we have the most specialized species of the genus, as in this form the posterior limb of the crescent of superior *m* 2, as figured, is totally absent. The form of the last superior molar is like that of *C. elephantopus*, and it is important to notice that this specimen is associated with the bilobate form of last inferior molar. The dimensions of the teeth in *C. hamatus* are the same as in *C. elephantopus*, and it may prove to be the same species. Flower and Lydekker² in their new work on the 'Mammalia' have incorrectly given Marsh's name of *C. hamatus* priority over that of *C. elephantopus* Cope.

Coryphodon obliquus Cope.

Last superior molar an elongated oval. Heel of last inferior molar trilobate; its internal enlargement a ridge.

The type of *C. obliquus* is a portion of a mandible bearing the last two molars, from New Mexico. This species has not been before recorded from the Big Horn Wahsatch. We are fortunate in having a fine specimen of it in the collection (No. 276) from this locality, consisting of the superior molar series with the mandibular dentition nearly complete.

It is exceptional to find together the superior and inferior molars of any of the species of *Coryphodon*. However, the specimens of *C. obliquus* in the American Museum collection are from one individual, and on that account they are of special value.

This is one of the few species of *Coryphodon* which can be readily distinguished by its size and dental characters from the larger species of the genus. The much smaller size of the teeth, the narrow and elongated form of the last upper molar with its long posterior crest readily distinguishes it from *C.anax*.

The second superior molar in *C. obliquus* has the posterior limb of the crescent well developed. The last lower molar is longer

¹ *Dinocerata*, 1884, p. 54.

² *Mammals, Living and Extinct*, Flower and Lydekker, 1891, p. 438, fig. 191.

than broad, its posterior crest is oblique to the anterior. The heel of this tooth has the entoconid large, and internally it becomes continuous with the low tuberculated ridge characteristic of the species.

The ramus of the mandible is much elongated and slender. The symphysis is long and strongly procumbent.

Measurements of Teeth and Jaw in C. obliquus.

	M.
Entire superior molar series.....	136
Superior molar 3. { ant. post.....	.024
{ trans.....	.037
Entire inferior molar series.....	152
Inferior molar 3. { ant. post.....	.037
{ trans.....	.022
Entire length of jaw.....	330
Depth of jaw below middle of m. 3... ..	.057

Coryphodon curvicristis Cope.

Heel of last inferior molar with crest extending inwards from hypoconid ; no entoconid differentiated. Superior incisors with prominent external rib.

The type of *C. curvicristis* is a second superior molar, a canine and a mandible of one side containing all the true molars intact. These specimens are from the Big Horn.

This species is of the same size approximately as *C. obliquus*, and is one of the most distinct of the genus. The peculiar character of the heel of the last inferior molar exists in no other known species ; the anterior limb of the heel is strongly marked. The crowns of the lower teeth are higher in proportion to their length than in the allied species. The second superior molar, associated with the type specimens, is intermediate in size between that of *C. anax* and *C. obliquus* ; its external crescent is high and turned strongly toward the posterior border of the tooth. A canine belonging to this species is much elongated, sharp and triangular in section.

A form of *Coryphodon* described by Prof. Cope as *C. marginatus* I cannot admit as a good species. The teeth upon which it was established are probably from the milk dentition. The characters of the upper molar of this type show that it may pertain to the milk series of *C. anax*.

Coryphodon anax Cope.

SYN.—*Bathmodon pachypus* Cope, and *Coryphodon lobatus* Cope.

Last superior molar oval in outline; external portion of anterior crest not connected with basal part of tooth by two ridges. Heel of last inferior molar trilobate in structure, with lobes nearly equal in size.

The largest known species of *Coryphodon*, namely, the *B. pachypus*, was established¹ upon the characters of the skeleton alone. The type of *C. anax* has both upper and lower molars (Fig. 2, *C* and *H*) associated with parts of the skeleton. I consider, as both of these types are from the same locality, and as the differential characters pointed out by Prof. Cope² are variable, that these two species are probably identical. I have compared parts of the skeleton of the specimen of the large species of *Coryphodon* in the American Museum collection with the type of *B. pachypus*, and find they correspond.

The last upper molar of *C. anax* (Fig. 2, *H*) is large and much extended transversely; it can be distinguished from that of *C. radians* by its larger size, and also from the fact that, in the type specimen, the anterior transverse crest at its external extremity is not bifid. Although this character may be variable, as shown by the specimen (No. 267) in the American Museum collection. The valley in the last superior molar separating the paracone from the anterior crest is not as deep as in *C. radians*; also the anterior limb of the external crescent is more oblique and crescentoid than in the latter species. The form of the last inferior molar is highly characteristic of *C. anax*; its heel is strongly trilobate, and the median lobe is well separated from the laterals. The size of this tooth, as already observed, is not larger than in some specimens of *C. radians*. Prof. Cope attempts to distinguish *C. anax* from *B. pachypus*, among other characters, upon the form of the facets of the astragalus and calcaneum. In the American Museum specimen (No. 258) the astragalus is the same size as in the type specimen of *B. pachypus* in Prof. Cope's collection. In this specimen the tibiale facet of the astragalus is well marked, but is discontinuous with the navicular; in this respect it resembles *C. radians*, and differs from the type specimen. The large size of the astragalus of *C. anax*, and especially its greater transverse extent, distinguishes it from that of *C. radians*.

¹ Proc. Acad. Nat. Sci. Phila., 1882, p. 294.

² Tertiary Vertebrata, pp. 551, 552.

The characters of the calcaneum mentioned by Cope as separating the two species will not hold good. In the American Museum collection there are three series of astragali and calcanea of *C. anax*; in the best-preserved specimen (No. 258) the sustentacular facet has an anterior prolongation; whereas in No. 273 the anterior portion is entirely absent. The sustentaculum in this specimen is of an oval form.

I have examined four sets of the astragali and calcanea of *C. anax*, and find that the characters of the inferior face of the astragalus are quite constant; I refer especially to the groove and foramen which are always placed on the astragalus between the ectal and sustentacular facets. In three specimens of the four the posterior opening of the groove is shut off by a bridge of bone connecting the ectal facet with the posterior median enlargement of the astragalus. In one specimen in the collection the bridge of bone is absent, and consequently there is a well-marked foramen; this specimen is associated with a calcaneum, in which the sustentacular facet is elongated.

The beautifully preserved pelvis in the American Museum collection has the same dimensions as that belonging to the type of *B. pachypus*; the femur, however, which is associated with it, is much smaller than that of *B. pachypus*. It is interesting to note that the American Museum femur has the same dimensions as that referred by Cope to the *C. anax*, thus offering more proof that *C. anax* and *B. pachypus* are the same species.

***Manteodon subquadratus* Cope.**

Last superior molar quadrate in form; hypocone smaller than protocone; paracone compressed and elongated.

The genus *Manteodon* was established by Prof. Cope¹ upon an upper true molar (Fig. 2, *F*) with fragments of teeth. I think Prof. Cope has correctly identified the single superior molar associated with the type as the last one of the superior series. We have in this tooth interesting characters which show us the modifications through which the *Coryphodon* molar has undergone. The fact that the last superior molar of *Manteodon* is quadritubercular in structure is unique, and occurs in no other genus of this family. This may indicate that *Manteodon* is not in the direct

¹ Proc. Am. Phil. Soc., 1881, p. 166.

line to *Coryphodon*; as in this case we should have to suppose the loss of the hypocone. The nearest approach to the rudiment of a hypocone on the superior molars of *Coryphodon* occurs in the *C. elephantopus*, although Marsh's figure of his *C. hamatus* probably indicates the presence of this cone in a rudimentary condition.

***Ectacodon cinctus* Cope.**

Last superior molar rectangular, larger than second; postero-external cusp widely separated from posterior crest.

The type of this genus and species is a finely-preserved series of upper molars in Prof. Cope's collection.

In the *E. cinctus* (Fig. 2, *G*) the anterior crest of the last upper molar is high, and its external termination is connected with the basal portion of the crown by only one ridge. The internal cingulum of this tooth is complete. In the second upper molar the external termination to the posterior limb of the crescent forms a prominent cusp, which is homologous with the postero-external cusp of the second superior molar of *C. testis*.

In this tooth the crescent is complete, and not reduced as in the latter.

This species is more closely related to *C. radians* than to any other, this being shown by the fact that in *C. radians* the last superior molar has traces of the posterior limb to the crescent; the postero-external cusp of *Ectacodon* being the remains of this posterior limb in the latter species.

C. elephantopus approaches the *E. cinctus* in the nearly square form of its last superior molar, but lacks the postero-external cusp of the latter.

I am doubtful whether *Ectacodon* should hold a generic rank, but as there are no direct transition forms as yet known between it and *Coryphodon* I retain it for the present.

In conclusion I wish to add, that owing to the material referable to the species of *Coryphodon* having been, in most cases, found so widely dissociated, it has been impossible to state accurately their number. I am convinced that the large number of species which have been founded by Prof. Cope should be greatly reduced; and that in many cases his species are to be considered merely varieties, and that often these varieties are merely individual variations in the same species due to age and sex.

Article XIII.—LIST OF TYPES OF LEPIDOPTERA IN THE EDWARDS COLLECTION OF INSECTS.

By WILLIAM BEUTENMÜLLER.

The object of the present paper is to place on record a list of the types of Lepidoptera in the collection of insects formed by the late Henry Edwards, which is now the property of the Museum. The collection consists of about 250,000 specimens and about 25,000 species, representing all the orders, and gathered in various parts of the globe. It is especially rich in Australian species, and in North American species from the Pacific Coast. A large number of Lepidoptera from this country were described by Mr. Edwards, and most of his types are in the collection, as well as many types of species described by other writers. The following list enumerates 465 species, which, together with the list¹ of 70 types from the Grote and Robinson collection, already recorded, aggregates 535 species of Lepidoptera, the types of which are now in the Museum collection. *Catocala angusii* Gr., *Catocala residua* Gr., *Attacus cinctus* Tepper, mentioned in the present list, are from the collection of insects recently donated to the Museum by James Angus, Esq.; and *Euclea elliotii* Pears. is from the Elliot collection, otherwise all are in the Edwards collection.

PAPILIONIDÆ.

Papilio pergamus Hy. Edw., Proc. Cal. Acad. Sc., Vol. V, p. 423.—One male, Santa Barbara, Cal.

Parnassius clodius var. **menetriesii** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 164.—Male and female, Sierra Nevada, Cal.

Parnassius smintheus var. **hermodur** Hy. Edw., Papilio, Vol. I, p. 4.—Two females, Southern Colorado.

Parnassius eversmanni var. **thor** Hy. Edw., Papilio, Vol. I, p. 2.—One female, Yukon River, Alaska.

¹ Bull. Am. Mus. Nat. Hist., Vol. IV, pp. 59-64.

Anthocharis ausonides var. **coloradensis** *Hy. Edw.*, *Papilio*, Vol. I, p. 50.—Male and female, Colorado.

Colias harfordii *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Feb. 5, 1877.—Five males, California.

Colias chrysomelas *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Feb. 5, 1877.—Two males, Napa Co., Cal.

Colias barbara *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Feb. 5, 1877.—Two females, Santa Barbara, Cal. (= *C. harfordii*, ♀.)

Colias eurydice var. **amorphæ** *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. VII, p. 169.—One male, Mendocino Co., Cal.

Colias moina *Strk.*, *Bull. Brooklyn Ent. Soc.*, Vol. III, p. 34.—Two females, Labrador.

Colias interior var. **laurentina** *Scud.*, *Proc. Boston Soc. Nat. Hist.*, Vol. XVIII, p. 189.—One female, Cape Breton Island.

NYMPHALIDÆ.

Argynnis liliana *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. VII, p. 170.—Three males, two females, Napa Co., Cal.

Argynnis columbia *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Dec. 17, 1877.—Two males, British Columbia.

Argynnis bischoffii *Edw.*, *Trans. Am. Ent. Soc.*, Vol. III, p. 189.—One female, Alaska.

Argynnis opis *Edw.*, *Trans. Am. Ent. Soc.*, Vol. V, p. 105.—One female, British Columbia.

Argynnis monticola var. **purpurascens** *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. VII, p. 170.—Three males, two females, Mt. Shasta, Cal.

Melitæa rubicunda *Hy. Edw.*, *Papilio*, Vol. I, p. 52.—Four males, three females, Sierra Nevada, Cal.

Melitæa chalcedon var. **dwinellei** *Hy. Edw.*, *Papilio*, Vol. I, p. 51.—Four examples, Shasta Co., Cal.

Melitæa nubigena var. **wheeleri** *Hy. Edw.*, *Papilio*, Vol. I, p. 52.—Male and female, Southern Nevada.

Melitæa leanira var. **obsoleta** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 171.—Four examples, Marin Co., Cal.

Limenitis lorquinii var. **eavesii** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 172.—One example, Virginia City, Nevada.

Cænonympha californica var. **eryngii** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 172.—Three examples, Mt. Shasta, Cal.

Cænonympha californica var. **pulla** Hy. Edw., Papilio, Vol. I, p. 51.—One male, San Mateo, Cal.

LYCÆNIDÆ.

Thecla melinus var. **pudica** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 172.—One male, Contra Costa Co., Cal.

Thecla putnami Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 143.—One specimen, in poor condition, Utah.

Thecla spadix Hy. Edw., Papilio, Vol. I, p. 53.—Two females, Tehachepi Pass, Southern California.

Thecla sæpium var. **fulvescens** Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 172.—Two examples, Havilah, Cal. One example, Tehachepi Pass, Cal.

Thecla nelsoni var. **exoleta** Hy. Edw., Papilio, Vol. I, p. 53.—Two females, Big Tree, Calaveras Co., Cal.

Thecla nelsoni var. **muiri** Hy. Edw., Papilio, Vol. I, p. 53.—Male and female, Mendocino Co., Cal.

Thecla adenostomatis Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 144.—Two examples, Tehachepi Pass, Southern California.

Thecla irus var. **mossii** Hy. Edw., Papilio, Vol. I, p. 54.—One male, Vancouver Island.

Lycæna clara Hy. Edw., Proc. Cal. Acad. Sc., Dec. 17, 1877.—Three examples, Tehachepi Pass, Southern California.

Lycæna speciosa Hy. Edw., Proc. Cal. Acad. Sc., Vol. VII, p. 173.—One male, Havilah, Kern Co., Cal.

SPHINGIDÆ.

Hemaris cynoglossum *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 88.—Three examples, California.

Hemaris rubens *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 88.—One male, Oregon.

Euproserpinus euterpe *Hy. Edw.*, Ent. Am., Vol. IV, p. 25.—One male, Southern California.

Smerinthus ophthalmicus var. **pallidulus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 91.—Four examples, California.

Triptogon modesta var. **occidentalis** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 92.—One female, California.

Phlegethontius cingulata var. **decolora** *Hy. Edw.*, Papilio, Vol. II, p. 11.—One male, Indian River, Florida.

Sphinx chersis var. **oreodaphne** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 93.—Male and female, St. Helena, Napa Co., California.

Sphinx perelegans *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 109.—One male, one female, Santa Clara Co., California.

Sphinx vancouverensis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 111.—One male, Big Tree, Cal. One female, Oregon.

Sphinx libocedrus *Hy. Edw.*, Papilio, Vol. I, p. 115.—One male, Prescott, Arizona.

Protoparce dilucida *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Four examples, Jalapa, Mexico.

Diludia languinosa *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Four examples, Jalapa, Mexico.

Isognathus inclitus *Hy. Edw.*, Ent. Am., Vol. III, p. 90.—Three examples, Jalapa, Mexico.

Chcerocampa turbata *Hy. Edw.*, Ent. Am., Vol. III, p. 89.—Three examples, Jalapa, Mexico.

ÆGERIDÆ.

Melittia snowii *Hy. Edw.*, Papilio, Vol. II, p. 53.—One male, Kansas.

Melittia gloriosa *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 71.—One female, California.

Melittia bergii *Hy. Edw.*, Papilio, Vol. III, p. 157.—One female, Buenos Ayres, S. A.

Larunda solituda *Hy. Edw.*, Papilio, Vol. I, p. 182.—One female, Western Kansas.

Trochilium simulans *Grote*, Bull. Brooklyn Ent. Soc., Vol. III, p. 78.—One female, Northern Illinois.

Trochilium pacificum *Hy. Edw.*, Papilio, Vol. I, p. 180.—Male and female, California.

Bembecia flavipes *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 76 (= *B. marginata* Harr.).—One male, one female, Long Island, N. Y.

Sciapteron robiniaæ *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 72.—Three males, Virginia City, Nevada. One female, California.

Sciapteron admirandus *Hy. Edw.*, Papilio, Vol. II, p. 54.—One male, Texas.

Sciapteron denotata *Hy. Edw.*, Papilio, Vol. II, p. 55.—One male, two females, Montana.

Fatua palmii *Hy. Edw.*, Can. Ent., Vol. XIX, p. 145.—One female, Enterprise, Florida.

Harmonia morrisonii *Hy. Edw.*, Papilio, Vol. II, p. 54.—One male, Montana. One female, Missouri.

Albuna rubescens *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 76 (= *A. hylotomiformis* Walk.).—One female, Colorado.

Albuna tanacetii *Hy. Edw.*, Papilio, Vol. I, p. 188.—Four females, Colorado, Vancouver and California.

Albuna artemisiæ *Hy. Edw.*, Papilio, Vol. I, p. 187.—One male, Sierra Nevada, Cal.

Albuna montana *Hy. Edw.*, Papilio, Vol. I, p. 188.—Three females, Colorado.

Albuna vancouverensis *Hy. Edw.*, Papilio, Vol. I, p. 188.—Four males, three females, Colorado and Vancouver Island.

Albuna coloradensis *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Colorado.

Albuna torva *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Vancouver Island.

Albuna resplendens *Hy. Edw.*, Papilio, Vol. I, p. 186.—One male, California.

Albuna rutilans *Hy. Edw.*, Papilio, Vol. I, p. 186.—One female, Virginia City, Nevada.

Albuna rileyana *Hy. Edw.*, Papilio, Vol. I, p. 187.—One female, Cadet, Missouri.

Sannina exitiosa var. *fitchii* *Hy. Edw.*, Papilio, Vol. II, p. 55.—One female, Florida.

Ægeria inusitata *Hy. Edw.*, Papilio, Vol. I, p. 201.—One male, Andover, Mass.

Ægeria quercus *Hy. Edw.*, Papilio, Vol. II, p. 98.—One male, Fort Grant, Arizona.

Ægeria prosopis *Hy. Edw.*, Papilio, Vol. II, p. 99.—One male, Fort Grant, Arizona.

Ægeria bolteri *Hy. Edw.*, Papilio, Vol. III, p. 155.—One male, Northern Illinois.

Ægeria flava *Hy. Edw.*, Papilio, Vol. I, p. 189.—One female, Colon, Isthmus of Panama.

Ægeria aurata *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Panama.

Ægeria novaroensis *Behrens*, Papilio, Vol. I, p. 199.—One male, one female, Soda Springs, Cal.

Ægeria lustrans *Grote*, Can. Ent., Vol. XII, p. 213.—One female, Ohio.

Ægeria saxifragæ *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Colorado.

Ægeria henshawii *Hy. Edw.*, Papilio, Vol. II, p. 56.—One female, Mingan Island, Labrador.

Ægeria corni *Hy. Edw.*, Papilio, Vol. I, p. 190.—One male, Massachusetts.

Ægeria verecunda *Hy. Edw.*, Papilio, Vol. I, p. 190.—Two females, Colorado.

Ægeria lupini *Hy. Edw.*, Papilio, Vol. I, p. 192.—Three males, three females, California.

Ægeria impropria *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Sierra Nevada, Cal.

Ægeria sexfasciata *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Dallas, Texas.

Ægeria corusca *Hy. Edw.*, Papilio, Vol. I, p. 193.—Two males, Texas.

Ægeria consimilis *Hy. Edw.*, Papilio, Vol. I, p. 194.—One male, Dorchester, Mass.

Ægeria hyperici *Hy. Edw.*, Papilio, Vol. I, p. 195.—Two females, West Virginia.

Ægeria eupatorii *Hy. Edw.*, Papilio, Vol. I, p. 193.—One male, Astoria, Long Island, N. Y.

Ægeria kœbeleii *Hy. Edw.*, Papilio, Vol. I, p. 196.—One male, Tallahassee, Florida.

Ægeria washingtonia *Hy. Edw.*, Papilio, Vol. I, p. 197.—One male, Washington.

Ægeria neglecta *Hy. Edw.*, Papilio, Vol. I, p. 197.—One male, Olympia, Wash.

Ægeria imperfecta *Hy. Edw.*, Papilio, Vol. I, p. 198.—One male, Colorado.

Ægeria hemizonæ *Hy. Edw.*, Papilio, Vol. I, p. 198.—Three females, Nevada and California.

Ægeria senecioides *Hy. Edw.*, Papilio, Vol. I, p. 198.—One male, California.

Ægeria opalescens *Hy. Edw.*, Papilio, Vol. I, p. 199.—Two males, Colorado and Nevada.

Ægeria gillæ *Hy. Edw.*, Papilio, Vol. I, p. 200.—One female, Colorado.

Ægeria mimuli *Hy. Edw.*, Papilio, Vol. I, p. 200.—One male, Colorado.

Ægeria madariæ *Hy. Edw.*, Papilio, Vol. I, p. 201.—One male, one female, California.

Ægeria albicornis *Hy. Edw.*, Papilio, Vol. I, p. 201.—One female, Centre, New York.

Ægeria auropurpurea *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 72.—One male, Texas.

Pyrrhotænia polygoni *Hy. Edw.*, Papilio, Vol. I, p. 202.—One male, San Miguel, Cal.

Pyrrhotænia fragariæ *Hy. Edw.*, Papilio, Vol. I, p. 202.—Two examples, Colorado.

Pyrrhotænia helianthi *Hy. Edw.*, Papilio, Vol. I, p. 203.—One female, Soda Springs, Cal.

Pyrrhotænia achillæ *Hy. Edw.*, Papilio, Vol. I, p. 203.—One male, San Rafael, Cal.

Pyrrhotænia eremocarpi *Hy. Edw.*, Papilio, Vol. I, p. 203.—One male, Sierra Nevada, Cal.

Pyrrhotænia meadii *Hy. Edw.*, Papilio, Vol. I, p. 204.—Two males, Lake Tahoe, Cal.

Pyrrhotænia orthocarpi *Hy. Edw.*, Papilio, Vol. I, p. 204.—Three males, Washoe Lake, Nevada.

Pyrrhotænia behrensii *Hy. Edw.*, Papilio, Vol. II, p. 123.—Three males, Soda Springs, Cal.

Pyrrhotænia wittfeldii *Hy. Edw.*, Papilio, Vol. III, p. 156.—Two females, Indian River, Florida.

Pyrrhotænia animosa *Hy. Edw.*, Papilio, Vol. III, p. 156.—One male, one female, Arizona.

Pyrrhotænia elda *Hy. Edw.*, Ent. Am., Vol. I, p. 49.—Two females, Siskiyou Co., Cal.

Pyrrhotænia floridensis *Grote*, Can. Ent., Vol. VII, p. 14.—One male, Enterprise, Florida.

Carmenta sanborni *Hy. Edw.*, Papilio, Vol. I, p. 185.—One female, Andover, Mass.

Carmenta nigella *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 75.—One male, Western New York.

Zenodoxus heucheræ *Hy. Edw.*, Papilio, Vol. I, p. 205.—Four examples, Sierra Nevada, Cal.

Zenodoxus potentillæ *Hy. Edw.*, Papilio, Vol. I, p. 205.—Three examples, Sierra Nevada, Cal.

Zenodoxus canescens *Hy. Edw.*, Papilio, Vol. I, p. 205.—One female, Arkansas.

Zenodoxus maculipes *G. & R.*, Trans. Am. Ent. Soc., Vol. II, p. 184.—One female, Texas.

ZYGÆNIDÆ.

Alypia matuta *Hy. Edw.*, Papilio, Vol. III, p. 33.—One male, Colorado.

Alypia wittfeldii *Hy. Edw.*, Papilio, Vol. III, p. 34.—Two males, one female, Indian River, Florida.

Alypia similis *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 14.—One female, California.

Alypia similis* var. *conjuncta *Hy. Edw.*, Papilio, Vol. III, p. 34.—One male, Contra Costa Co., Cal.

Alypia brannani *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 8.—One male, Sierra Nevada, Cal.

Pseudalypia crotchii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 111.—One female, San Diego, Cal.

Scepsis mathewi *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 184.—Three examples, Vancouver Island.

Scepsis gravis *Hy. Edw.*, Ent. Am., Vol. II, p. 8.—Three specimens, Mendocino Co., Cal.

Scepsis fulvicollis var. **pallens** *Hy. Edw.*, Ent. Am., Vol. II, p. 8.—Four examples, Denver, Colorado.

Scepsis edwardsii *Grote*, Papilio, Vol. I, p. 4.—Male and female, Indian River, Florida.

Ctenucha walsinghamii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 112 (= *C. rubroscapis* Menet.).—One female, Fort Crook, Oregon.

Ctenucha imitata *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Three males, Jalapa, Mexico.

Ctenucha sceansiformis *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Four males, Jalapa, Mexico.

Ctenucha proxima *Hy. Edw.*, Papilio, Vol. IV, p. 14.—One female, Jalapa, Mexico.

Ctenucha modulata *Hy. Edw.*, Papilio, Vol. IV, p. 14.—One female, Jalapa, Mexico.

Ctenucha pyrrhoura *Hulst*, Bull. Brooklyn Ent. Soc., Vol. III, p. 77 (= *C. harrisii* Bd.).—One male, Colorado.

Lycomorpha notha *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One male, Jalapa, Mexico.

Lycomorpha sinuata *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One female, Jalapa, Mexico.

Lycomorpha angusta *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—One male, Jalapa, Mexico.

Lycomorpha marginata *Hy. Edw.*, Papilio, Vol. IV, p. 13.—One male, Mexico.

Lycomorpha coccinea *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—Two females, Arizona.

Gnophæla vermiculata var. **continua** *Hy. Edw.*, Papilio, Vol. I, p. 80.—Two examples, Colorado.

Gnophæla disjuncta *Hy. Edw.*, Ent. Am., Vol. I, p. 128.—One female, Jalapa, Mexico.

Anatolmis fulgens *Hy. Edw.*, Papilio, Vol. I, p. 116.—One male, Prescott, Arizona.

Tripocris basalis *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—Six examples, Jalapa, Mexico.

Tripocris aversus *Hy. Edw.*, Papilio, Vol. IV, p. 13.—One male, Jalapa, Mexico.

Penthetria majuscula *Hy. Edw.*, Papilio, Vol. I, p. 80.—One male, Georgia.

Penthetria parvula *Hy. Edw.*, Papilio, Vol. I, p. 80.—One male, Indian River, Florida.

Eusemia schausii *Hy. Edw.*, Ent. Am., Vol. III, p. 90.—Three examples, Jalapa, Mexico.

BOMBYCIDÆ.

Erias obliquata *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—One male, Neuces River, Texas.

Sarrothripa columbiana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 184.—Two examples, Vancouver Island.

Nola anfracta *Hy. Edw.*, Papilio, Vol. I, p. 12.—One male, Yosemite Valley, Cal.

Hypoprepia plumbea *Hy. Edw.*, Ent. Am., Vol. II, p. 9.—One male, one female, Minneapolis, Minn.

Clemensia irrorata *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 185.—One female, Vancouver Island.

Lithosia candida *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 185.—One female, Vancouver Island.

Crocota ostenta *Hy. Edw.*, Papilio, Vol. I, p. 12.—One male, Prescott, Arizona.

Arctia incorrupta *Hy. Edw.*, Papilio, Vol. I, p. 38.—Three males, Prescott, Arizona. One male, Oregon.

Arctia achaia var. **barda** *Hy. Edw.*, Papilio, Vol. I, p. 39.—Two males, Northern California and Dalles, Oregon.

Arctia brucei *Hy. Edw.*, Ent. Am., Vol. III, p. 183.—Male and female, Colorado.

Arctia superba *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 227.—One male, Vancouver Island.

Antarctia pteridis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 264.—One male, Vancouver Island. (= *A. punctata*.)

Antarctia punctata var. **proba** *Hy. Edw.*, Papilio, Vol. I, p. 39.—Male and female, Sierra Nevada, Cal.

Daritis thetis var. **howardi** *Hy. Edw.*, Ent. Am., Vol. II, p. 165.—One male, New Mexico.

Euprepia opulenta *Hy. Edw.*, Papilio, Vol. I, p. 38.—One male, Yukon River, Alaska.

Euprepia caja var. **utahensis** *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—Thirteen examples, Salt Lake, Utah.

Nemeophila selywnii *Hy. Edw.*, Can. Ent., Vol. XVII, p. 65.—One male, Vancouver Island.

Kodiosoma fulva *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 67.—One male, California.

Nelphe carolina *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—One male, Indian River, Florida.

Halisidota maculata var. **alni** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 129.—Two females, Mt. Shasta, Cal.

Halisidota davisii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 365.—One male, Arizona.

Halisidota ingens *Hy. Edw.*, Papilio, Vol. I, p. 39.—One female, Prescott, Arizona.

Halisidota laqueata *Hy. Edw.*, Ent. Am., Vol. II, p. 166.—
One female, Texas.

Halisidota propinqua *Hy. Edw.*, Papilio, Vol. IV, p. 76.—
One male, Jalapa, Mexico.

Euhalisidota aperta *Hy. Edw.*, Papilio, Vol. IV, p. 77.—
One male, Jalapa, Mexico.

Euhalisidota lurida *Hy. Edw.*, Ent. Am., Vol. III, p. 91.—
Male and female, Jalapa, Mexico.

Robinsonia perfecta *Hy. Edw.*, Papilio, Vol. IV, p. 60.—
Male and female, Jalapa, Mexico.

Euchætès inopinatus *Hy. Edw.*, Papilio, Vol. II, p. 13.—
One male, Indian River, Florida.

Euchætès yosemite *Hy. Edw.*, Papilio, Vol. III, p. 146.—
One male, two females, Yosemite Valley, Cal.

Euchætès scepsiformis *Graef*, Ent. Am., Vol. III, p. 43.—
One male, Texas.

Euchætès fumidus *Hy. Edw.*, Papilio, Vol. IV, p. 61.—
Male and female, Jalapa, Mexico.

Euchætès immanis *Hy. Edw.*, Papilio, Vol. IV, p. 75.—
Male and female, Jalapa, Mexico.

Euchætès emendatus *Hy. Edw.*, Papilio, Vol. IV, p. 61.—
Two males, one female, Jalapa, Mexico.

Orgyia badia *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V,
p. 188.—Male and female, Vancouver Island. (= *O. antiqua* L.)

Orgyia gulosa *Hy. Edw.*, Papilio, Vol. I, p. 61.—Male and
female, California.

Orgyia cana *Hy. Edw.*, Papilio, Vol. I, p. 62.—Two males,
Havilah, Cal.

Orgyia leucostigma var. *obliviosa* *Hy. Edw.*, Ent. Am.,
Vol. II, p. 13.—Three males, two females, New Jersey.

Euclea elliotii *Pears*, Ent. Am., Vol. II, p. 209.—One male,
New York.

Limacodes beutenmuelleri *Hy. Edw.*, Can. Ent., Vol. XIX, p. 145.—One female, Enterprise, Florida.

Limacodes parallela *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—One male, Indian River, Florida.

Lagoa superba *Hy. Edw.*, Papilio, Vol. IV, p. 79.—Male and female, Jalapa, Mexico.

Psyche fragmentella *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 142.—Larval cases. (Imago unknown.)

Psyche coniferella *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 142.—Larval cases. (Imago unknown.)

Oiketicus davidsonii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 142.—Larval cases. (Imago unknown.)

Pseudopsyche exigua *Hy. Edw.*, Papilio, Vol. II, p. 125.—One male, Arizona.

Nadata behrensii *Hy. Edw.*, Ent. Am., Vol. I, p. 49.—Male and female, California.

Ichthyura brucei *Hy. Edw.*, Ent. Am., Vol. I, p. 17.—One male, Colorado.

Ichthyura luculenta *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—Two males, Northern Indiana.

Ichthyura jocosa *Hy. Edw.*, Ent. Am., Vol. II, p. 10.—One female, Indian River, Florida.

Ichthyura bifaria *Hy. Edw.*, Ent. Am., Vol. II, p. 167.—One male, Soda Springs, Cal.

Apatelodes torrefacta var. **floridana** *Hy. Edw.*, Ent. Am., Vol. II, p. 13.—One male, Indian River, Florida.

Apatelodes vivax *Hy. Edw.*, Papilio, Vol. IV, p. 77.—Male and female, Jalapa, Mexico.

Apatelodes diffidens *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—Male and female, Jalapa, Mexico.

Gluphisia wrightii *Hy. Edw.*, Ent., Am., Vol. II, p. 11.—One female, San Bernardino, Cal.

Gluphisia ridenda *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Three males, Denver, Colorado.

Gluphisia rupta *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—One male, Denver, Colorado.

Gluphisia albofascia *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Two males, Salt Lake City, Utah.

Gluphisia formosa *Hy. Edw.*, Ent. Am., Vol. II, p. 12.—Three males, Salt Lake City, Utah.

Gluphisia severa *Hy. Edw.*, Ent. Am., Vol. II, p. 167.—One female, Soda Springs, Cal.

Notodonta notaria *Hy. Edw.*, Ent. Am., Vol. I, p. 17 (= *Lophopteryx elegans* Strk.).—Four specimens, Colorado.

Lophodonta plumosa *Hy. Edw.*, Ent. Am., Vol. II, p. 14.—One male, Denver, Colorado.

Pheosia portlandia *Hy. Edw.*, Ent. Am., Vol. II, p. 168.—Male and female, Portland, Oregon.

Ædemasia perangulata *Hy. Edw.*, Papilio, Vol. II, p. 125.—One male, Colorado.

Ædemasia salicis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VII, p. 121.—One male, Mt. Shasta, Cal.

Coelodasys conspecta *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 366.—One male, Napa Co., California.

Ianassa lignicolor var. **coloradensis** *Hy. Edw.*, Ent. Am., Vol. I, p. 17.—Three examples, Salt Lake City, Utah.

Ianassa laciniosa *Hy. Edw.*, Ent. Am., Vol. I, p. 129.—Male and female, Jalapa, Mexico.

Attacus cinctus *Tepper*, Bull. Brooklyn Ent. Soc., Vol. V, p. 65.—One female, Southern Arizona.

Hemileuca maia var. **lucina** *Hy. Edw.*, Ent. Am., Vol. II, p. 14.—Three males, two females, Maine.

Hyperchiria zephyria *Grote*, *Tran. Kan. Acad. Sc.*, Vol. VIII, p. 147.—One female, near Hot Springs, Las Vegas, New Mexico.

Hyperchiria schausii *Hy. Edw.*, *Papilio*, Vol. IV, p. 16.—Male and female, Jalapa, Mexico.

Euleucophæus tricolor *Pack.*, *Rep. Peab. Acad. Sc.*, April, 1872.—One male, New Mexico.

Euleucophæus sororius *Hy. Edw.*, *Papilio*, Vol. I, p. 100.—One female, La Paz, Lower California.

Thauma ribesii *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. V, p. 265.—One female, Vancouver Island.

Gloveria arizonensis *Pack.*, *Papilio*, Vol. IV, p. 107.—One male, Arizona.

Gloveria olivacea *Hy. Edw.*, *Papilio*, Vol. IV, p. 108.—Two males, two females, Jalapa, Mexico.

Clisiocampa thoracica *Stretch*, *Papilio*, Vol. I, p. 68.—One male, California.

Bombyx habitus *Hy. Edw.*, *Ent. Am.*, Vol. III, p. 91.—One male, Jalapa, Mexico.

Hepialus mcglashanii *Hy. Edw.*, *Ent. Am.*, Vol. II, p. 14.—Three examples, Truckee, Cal.

Hepialus mathewi *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. V, p. 265.—Male and female, Vancouver Island.

Hepialus rectus *Hy. Edw.*, *Papilio*, Vol. I, p. 35.—One female, Contra Costa Co., Cal.

Hepialus anceps *Hy. Edw.*, *Papilio*, Vol. I, p. 36.—Three examples, Mendocino Co., Cal.

Hepialus inutilis *Hy. Edw.*, *Papilio*, Vol. I, p. 36.—Male and female, Summit, Sierra Nevada, Cal.

Hepialus modestus *Hy. Edw.*, *Proc. Cal. Acad. Sc.*, Vol. V, p. 112.—One male, San Miguel, Cal.

Hepialus tacomæ *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 365.—One specimen, Tacoma, Washington.

Hepialus furcatus *Grote*, Can. Ent., Vol. XX, p. 30 (= *H. gracilis* Gr.).—One male, Colorado.

Hepialus montana *Stretch*, Zygæ. & Bomb. N. Am., Vol. I, p. 105.—One female, Sierra Nevada, Cal.

Phassus triangularis *Hy. Edw.*, Ent. Am., Vol. I, p. 129.—Two females, Jalapa, Mexico.

NOCTUIDÆ.

Bombycia improvisa *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 189 (as *Cymatophora improvisa*).—One male, Washington.

Bombycia tearlei *Hy. Edw.*, Ent. Am., Vol. II, p. 11 (as *Gluphisia tearlei*).—One female, Truckee, Sierra Nevada, Cal.

Raphia pallula *Hy. Edw.*, Ent. Am., Vol. II, p. 168.—Two females, Soda Springs, Siskiyou Co., Cal.

Bryophila viridata *Harv.*, Can. Ent., Vol. VIII, p. 275 (as *Jaspidia viridata*).

Diphthera spissa *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—Male and female, Jalapa, Mexico.

Diphthera spissa var. **pollux** *Hy. Edw.*, Ent. Am., Vol. III, p. 92.—One male, Jalapa, Mexico.

Cerma olivacea *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 103.—One male, Sierra Nevada, Cal.

Dicopis damalis *Grote*, Bull. U. S. Geol. Surv., Vol. V, p. 208.—One male, Havilah, Cal.

Acronycta lupini *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 79.—One female, California.

Acronycta spini *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 78.—Male and female, Lone Mountains, Cal.

Acronycta felina *Grote*, Bull. U. S. Geol. Surv., Vol. V, p. 208.—One female, Summit, Sierra Nevada, Cal.

***Acronycta americana* var. *obscura* Hy. Edw.**, Ent. Am., Vol. II, p. 169.—Four examples, Kansas City, Mo.

***Copablepharon album* Harv.**, Can. Ent., Vol. VIII, p. 35.—One example, Oregon.

***Agrotis havilæ* Grote**, Bull. U. S. Geol. Surv. (Hayden), Vol. VI, p. 157.—Three examples, Southern California.

***Agrotis milleri* Grote**, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 78.—One female, Sierra Nevada, Cal.

***Agrotis euroides* Grote**, Proc. Acad. Nat. Sc. Phila., 1874, p. 202.—One female, California.

***Agrotis vancouverensis* Grote**, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 134.—One example, Vancouver Island.

***Agrotis niveivenosa* Grote**, Bull. U. S. Geol. Surv. (Hayden), Vol. V, p. 206.—One female, Colorado.

***Agrotis oblongistigma* Smith**, Proc. U. S. Nat. Mus., Vol. X, p. 454.—One example, Montana.

***Agrotis remota* Smith**, Trans. Am. Ent. Soc., Vol. XVII, p. 48.—Two examples, Sierra Nevada, Cal.

***Agrotis rena* Smith**, Trans. Am. Ent. Soc., Vol. XVII, p. 53.—Three examples, Sierra Nevada, Cal.

***Agrotis nostra* Smith**, Trans. Am. Ent. Soc., Vol. XVII, p. 55.—Four examples, Sierra Nevada, Cal.

***Agrotis lutulentus* Smith**, Trans. Am. Ent. Soc., Vol. XVII, p. 50.—Two males, Sierra Nevada, Cal.

***Agrotis alticola* Smith**, Trans. Am. Ent. Soc., Vol. XVII, p. 51.—Three specimens, Sierra Nevada, Cal.

***Agrotis pallidicollis* Grote**, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 79 (as *A. cinereicollis*).—One female, California.

***Agrotis brunneigera* Grote**, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 80.—One female, Vancouver Island.

***Mamestra comis* Grote**, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 85.—One male, Vancouver Island.

Mamestra minorata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 467.—One male, Havilah, Cal.

Mamestra lepidula *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 463.—One female, Texas.

Mamestra rubrica var. **subapicalis** *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 462.—One female, Havilah, Cal.

Mamestra u-scripta *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 228.—Three examples, Sierra Nevada, Cal.

Mamestra invalida *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 225.—Three examples, Sierra Nevada, Cal.

Mamestra circumcincta *Smith*, Proc. U. S. Nat. Mus., Vol. XIV, p. 253.—One male, two females, Sierra Nevada, Cal.

Hadena violacea *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. VI, p. 261.—One example, Mt. Shasta District, Cal.

Hadena cinefacta *Grote*, Papilio, Vol. I, p. 77.—One female, Southern California.

Hadena unicincta *Smith*, MSS.—Male and female, Sierra Nevada, Cal.

Hadena centralis *Smith*, Proc. U. S. Nat. Mus., Vol. XIII, p. 441.—Three examples, Sierra Nevada, Cal.

Hadena rectifascia *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 108 (as *Dryobota rectifascia*).—Two examples, Sierra Nevada, Cal.

Hadena latifascia *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 108 (= *Homohadena elda* ♂ French).—Male and female, Sierra Nevada, Cal.

Hadena dunbari *Harv.*, Can. Ent., Vol. VIII, p. 52.—One female, Vancouver Island.

Pseudanarta flava var. **crocea** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 133.—Three females, Dalles, Oregon.

Perigea niveirena *Harv.*, Can. Ent., Vol. VIII, p. 53.—One female, Vancouver Island.

Perigea fasciata *Hy. Edw.*, Ent. Am., Vol. II, p. 169.—Six specimens, Colorado Desert.

Scotogramma stretchii *Hy. Edw.*, Can. Ent., Vol. XIX, p. 146.—Two examples, Colorado Desert.

Homohadena deserta *Smith*, Proc. U. S. Nat. Mus., Vol. XIII, p. 402.—One example, Colorado Desert.

Perigonica angulata *Smith*, Ent. Am., Vol. VI, p. 124.—Male and female, Sierra Nevada, Cal.

Perigrapha prima *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 119 —One female, Sierra Nevada, Cal.

Perigrapha plusiiformis *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. V, p. 267 (as *Stretchia plusiæformis*).—One male, Nevada.

Perigrapha inferior *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 477.—One male, Havilah, Cal.

Oncocnemis mirificalis *Grote*, Bull. U. S. Geol. Surv. (Hayden), Vol. V, p. 207.—One female, Nevada.

Oncocnemis simplex *Smith*, Insect Life, Vol. I, p. 20.—One example, Ashley Valley, Utah.

Aporophyla yosemite *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. I, p. 113 (as *Cucullia yosemite*).

Apamea lunata *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 110.—One example, Mt. Shasta District, Cal.

Tæniocampa pulchella *Harv.*, Can. Ent., Vol. VIII, p. 54.—One female, California.

Tæniocampa subterminata *Smith*, Proc. U. S. Nat. Mus., Vol. X, 476.—One female, New York.

Tæniocampa pectinata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 475.—One male, Havilah, Cal.

Tæniocampa curtica *Smith*, Ent. Am., Vol. VI, p. 122.—Male and female, Sierra Nevada, Cal.

Orthodes irrorata *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 478.—One male, Washington.

Trichoclea edwardsii *Smith*, Proc. U. S. Nat. Mus., Vol. X, p. 460.—One male, California.

Lithophane carbonaria *Harv.*, Can. Ent., Vol. VIII, p. 55.—One female, California.

Lithophane contenta *Grote*, Can. Ent., Vol. XII, p. 216.—One example, California.

Lithophane oregonensis *Harv.*, Can. Ent., Vol. VIII, p. 55.—One female, Oregon.

Lithophane washingtonia *Grote*, Papilio, Vol. III, p. 74.—One male, Soda Springs, Mt. Shasta, Cal.

Lithophane gausapata *Grote*, Papilio, Vol. III, p. 77.—One example, Soda Springs, Mt. Shasta, Cal.

Cleophane eulepis *Grote*, Bull. Buff. Soc. Nat. Hist., Vol. III, p. 86.—One female, Oregon.

Deva morigera *Hy. Edw.*, Ent. Am., Vol. II, p. 169.—One female, Colorado.

Deva palligera *Grote*, Papilio, Vol. I, p. 35.—One specimen, Sierra Nevada, Cal.

Plusia celsa *Hy. Edw.*, Papilio, Vol. I, p. 101.—One female, Mt. Hood, Oregon.

Plusia californica var. *russea* *Hy. Edw.*, Ent. Am., Vol. II, p. 170.—Two females, Colorado and California.

Plusia vaccinii *Hy. Edw.*, Ent. Am., Vol. II, p. 170.—One female, Mt. Washington, New Hampshire.

Plusia howardi *Hy. Edw.*, Proc. Cal. Acad. Sc., March 5, 1877.—One example, Prescott, Arizona.

Plusia scapularis *Hy. Edw.*, Papilio, Vol. II, p. 127.—One example, Washington.

Pleroma obliquata *Smith*, Trans. Am. Ent. Soc., Vol. XVIII, p. 114.—One female, Sierra Nevada, Cal.

Anarta kelloggii *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 133. One female, Sierra Nevada, Cal.

Triocnemis saporis Grote, Papilio, Vol. I, p. 77.—One example, Southern California.

Euros proprius Hy. Edw., Papilio, Vol. I, p. 19.—One female, Mt. Shasta District, Cal.

Melicleptria exalta Hy. Edw., Papilio, Vol. IV, p. 124.—One male, San Antonio, Texas.

Melicleptria fasciata Hy. Edw., Proc. Cal. Acad. Sc., Vol. VI, p. 134.—Two examples, Placer Co., California.

Melicleptria elaborata Hy. Edw., Papilio, Vol. I, p. 21.—One example, Colorado.

Melicleptria belladonna Hy. Edw., Papilio, Vol. I, p. 20.—One female, Southern Utah.

Melicleptria oregonica Hy. Edw., Proc. Cal. Acad. Sc., Vol. VI, p. 135.—Three examples, Sierra Nevada, Cal. One example, Colorado.

Lygranthœcia walsinghami Hy. Edw., Papilio, Vol. I, p. 20.—Male and female, Klamath Lake, Oregon.

Adonisea pulchripennis var. **languida** Hy. Edw., Papilio, Vol. I, p. 20.—One male, Havilah, Cal.

Xanthothrix ranunculi Hy. Edw., Proc. Cal. Acad. Sc., July 1, 1878.—Five examples, Havilah, Kern Co., Cal.

Xanthothrix neumœgeni Hy. Edw., Papilio, Vol. I, p. 101.—Two specimens, Santa Barbara Co., Cal.

Tarache arizonæ Hy. Edw., Proc. Cal. Acad. Sc., July 1, 1878 (as *Thalpochares arizonæ*).—Two examples, Prescott, Arizona.

Tarache sedata Hy. Edw., Papilio, Vol. I, p. 23.—One specimen, Prescott, Arizona.

Annaphila superba Hy. Edw., Proc. Cal. Acad. Sc., Vol. VI, p. 139.—Two specimens, Napa and Marin Co., Cal.

Annaphila domina Hy. Edw., Proc. Cal. Acad. Sc., Vol. VI, p. 138.—One female, San Mateo Co., Cal.

Annaphila aurantiaca *Hy. Edw.*, Papilio, Vol. I, p. 23.—One example, Geysers, Cal.

Annaphila germana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 138.—One female, Napa Co., Cal.

Annaphila salicis *Hy. Edw.*, Papilio, Vol. I, p. 23.—One example, Oregon.

Annaphila pustulata *Hy. Edw.*, Papilio, Vol. I, p. 23.—One female, Prescott, Arizona.

Annaphila lithosina *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 137.—One example, Havilah, Cal.

Tripudia opipara *Hy. Edw.*, Papilio, Vol. I, p. 117 (as *Oribates opiparus*).—One male, Texas.

Tripudia limbata *Hy. Edw.*, Papilio, Vol. I, p. 22 (as *Oribates limbatus*).—Two examples, Mazatlan, Mexico.

Gyros muirii *Hy. Edw.*, Papilio, Vol. I, p. 22 (as *Oribates muirii*).—Two specimens, Havilah, Cal.

Axenus arvalis var. **amplus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 136.—Two examples, Klamath Lake, Oregon.

Axenus arvalis var. **ochraceus** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 136.—One female, San Diego, Cal.

Fruva acerba *Hy. Edw.*, Papilio, Vol. I, p. 24.—Two examples, Sonoma Co., Cal.

Fruva accepta *Hy. Edw.*, Papilio, Vol. I, p. 24.—Male and female, Tallahassee, Florida.

Fruva modesta *Hy. Edw.*, Papilio, Vol. IV, p. 124.—Two examples, California.

Fruva deleta *Hy. Edw.*, Papilio, Vol. IV, p. 124.—One male, Virginia City, Nevada.

Litocala sexsignata var. **deserta** *Hy. Edw.*, Papilio, Vol. I, p. 25.—Two males, two females, Colorado and Arizona.

Syneda sesposita *Hy. Edw.*, Papilio, Vol. I, p. 25.—One male, Southern Colorado.

Syneda faceta *Hy. Edw.*, Papilio, Vol. I, p. 119.—One male, Indian River, Florida.

Syneda mirifica *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—Two examples, Virginia City, Nevada.

Syneda hastingsii *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One example, Dalles, Oregon.

Syneda hastingsii var. **perpallida** *Hy. Edw.*, Papilio, Vol. I, p. 25.—One female, Summit, Sierra Nevada, Cal.

Syneda saxeae *Hy. Edw.* (= *S. allenii*), Papilio, Vol. I, p. 26.—One specimen, Colorado.

Cirrhobolina tetrica *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One male, Sacramento, Cal.

Synedoida inepta *Hy. Edw.*, Papilio, Vol. I, p. 27.—One female, Southern Colorado.

Synedoida biformata *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—Two males, Havilah, Kern Co., Cal.

Synedoida scrupulosa *Hy. Edw.*, Proc. Cal. Acad. Sc., July 1, 1878.—One male, two females, Havilah, Kern Co., Cal.

Synedoida morbosa *Hy. Edw.*, Papilio, Vol. I, p. 27.—Male and female, Southern Colorado. One male, Prescott, Arizona.

Synedoida sabulosa *Hy. Edw.*, Papilio, Vol. I, p. 26.—One female, Southern Colorado.

Catocala amica var. **nerissa** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 61.—One specimen, Southwestern Texas.

Catocala dulciola *Grote*, Papilio, Vol. I, p. 5.—One female, Dayton, Ohio.

Catocala badia var. **phœbe** *Hy. Edw.*, Papilio, Vol. IV, p. 125.—Two examples, New Hampshire.

Catocala neogama var. **snowiana** *Grote*, New Check List Noct., p. 41, 1876.—One female, Kansas.

Catocala andromache *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One male, San Bernardino, Cal.

Catocala fratercula var. **jacquenetta** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 60.—One female, Albany, New York.

Catocala fratercula var. **hero** *Hy. Edw.*, Papilio, Vol. IV, p. 125.—Two examples, Florida.

Catocala cordelia *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 59 (= *C. amasia*).—One male, Tallahassee, Florida.

Catocala ultronia var. **celia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 58.—Four examples, Indian River, Florida.

Catocala ultronia var. **mopsa** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—Two examples, Florida.

Catocala ultronia var. **adriana** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—One example, New York.

Catocala verrillana var. **violenta** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 58 (as *C. violenta*).—One example, Southern Colorado.

Catocala stretchii var. **hippolyta** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 211 (as *C. hippolyta*).—One male, San Mateo Co., Cal.

Catocala cassandra *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 214.—One female, Guadalajara, Mexico.

Catocala stretchii var. **portia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. II, p. 94 (as *C. portia*).—One male, Lake Tahoe, Cal.

Catocala jessica *Hy. Edw.*, Proc. Cal. Acad. Sc., January 15, 1877 (= *C. stretchii* Behr.).—Two examples, Havilah, Kern Co., Cal.

Catocala mariana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 210.—One male, Vancouver Island.

Catocala mariana var. **francisca** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.—Two males, Humboldt Co., Cal.

Catocala hermia *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. II, p. 93.—One female, Colorado.

Catocala irene var. **virgilia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—Three males, one female, Mendocino Co., Cal.

Catocala irene var. **valerja** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—One female, Arizona.

Catocala irene var. **volumnia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 56.—One example, Mendocino Co., Cal.

Catocala elda *Behrens*, Can. Ent., Vol. XIX, p. 199.—One female, Portland, Oregon. .

Catocala rosalinda *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 55.—One example, Albany, N. Y.

Catocala miranda *Hy. Edw.*, Papilio, Vol. I, p. 118.—One male, Washington, D. C.

Catocala cara var. **silvia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 57.

Catocala augusta *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 184.—One female, San Diego, Cal.

Catocala luciana *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 211.—Three examples, Colorado.

Catocala californica var. **cleopatra** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 209 (as *C. cleopatra*).—One male, Contra Costa Co., Cal.

Catocala californica var. **perdita** *Hy. Edw.*, Proc. Cal. Acad. Sc., Vol. VI, p. 211 (as *C. perdita*).—Two examples, San Mateo Co., Cal.

Catocala relictæ var. **phrynia** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 54.—One male, Albany, N. Y.

Catocala relictæ var. **bianca** *Hy. Edw.*, Bull. Brooklyn Ent. Soc., Vol. III, p. 54.—Male and female, Albany, N. Y.

Catocala lacrymosa var. **emilia** *Hy. Edw.*, Papilio, Vol. I, p. 117.—One female, Long Island, N. Y.

Catocala angusii *Gr.*, Can. Ent., Vol. VIII, p. 229.—One male, West Farms, New York City.

Catocala residua *Gr.*, Proc. Boston Soc. Nat. Hist., Vol. XVI, p. 242.—Male and female, West Farms, New York City.

Antiblemma guttula *Hy. Edw.*, Papilio, Vol. II, p. 129.—One example, Georgia.

Phoberia indiscreta *Hy. Edw.*, Ent. Am. Vol. II, p. 170.—One female, Havilah, Cal.

Pleonectyptera obliquialis *Hy. Edw.*, Ent. Am., Vol. II, p. 171.—One example, Texas.

Homoptera rubi *Hy. Edw.*, Papilio, Vol. I, p. 28.—Male and female, Havilah, Cal.

GEOMETRIDÆ.

Azelina australata *Hulst*, Ent. Am., Vol. I, p. 205.—One male, Indian River, Florida.

Tetracis mellitularia *Hulst*, Ent. Am., Vol. I, p. 202.—Two females, Sierra Nevada, Cal.

Anaploides festaria *Hulst*, Ent. Am., Vol. II, p. 121.—One male, San Francisco, Cal.

Geometra illustraria *Hulst*, Ent. Am., Vol. II, p. 121.—One female, California.

Eucrostis saltusaria *Hulst*, Ent. Am., Vol. II, p. 122.—One female, Indian River, Florida.

Eucrostis jaspidiaria *Hulst*, Ent. Am., Vol. II, p. 122.—One male, Indian River, Florida.

Acidalia 5-lineata var. **fuscata** *Hulst*, Ent. Am., Vol. II, p. 187.—One female, Summit, Sierra Co., Cal.

Marmopteryx annellata *Hulst*, Ent. Am., Vol. II, p. 191.—One female, Havilah, Cal.

Marmopteryx morrisata *Hulst*, Ent. Am., Vol. II, p. 190.—One female, Nevada.

Semiothisa umbriferata *Hulst*, Ent. Am., Vol. II, p. 189.—One male, California.

***Halia tripunctaria* Pack.**, Proc. Boston Soc. Nat. Hist., Vol. XVI, p. 26.—One female, California.

***Tephrosia carnearia* Hulst**, Ent. Am., Vol. III, p. 216.—Male and female, Havilah, Cal.

***Tephrosia celataria* Hulst**, Ent. Am., Vol. III, p. 216.—One male, Havilah, Cal.

***Tephrosia fautaria* Hulst**, Ent. Am., Vol. III, p. 216.—One female, California.

***Boarmia furfuraria* Hulst**, Ent. Am., Vol. III, p. 214.—One male, California.

***Boarmia plumogeraria* Hulst**, Ent. Am., Vol. III, p. 216.—One male, California.

***Scotosia meadii* Pack.**, Sixth Rep. Peab. Acad. Sc., p. 41 (as *Scotosia meadii*).—One female, Colorado.

***Lobophora montanata* Pack.**, Sixth Rep. Peab. Acad. Sc., p. 40.—One example, Colorado.

***Cidaria nocticolata* Hulst**, Bull. Brooklyn Ent. Soc., Vol. IV, p. 26.—One female, Colorado.

***Cidaria opacaria* Hulst**, Bull. Brooklyn Ent. Soc., Vol. IV, p. 27.—One male, Colorado.

***Phrygionis auriferaria* Hulst**, Ent. Am., Vol. II, p. 188.—One example, Florida.

***Hemerophila packardaria* Hulst**, Ent. Am., Vol. III, p. 217.—One male, California.

***Aspilates behrensaria* Hulst**, Ent. Am., Vol. II, p. 210.—One male, Knight Valley, Cal.

***Eois ferrugata* var. *russata* Hulst**, Ent. Am., Vol. II, p. 187.—One male, New York.

***Cleoria punctomacularia* Hulst**, Ent. Am., Vol. III, p. 214.—One male, Vancouver Island.

Triphosa dubitata var. **pustularia** *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One female, Soda Springs, Cal.

Triphosa badiaria *Hy. Edw.*, Ent. Am., Vol. I, p. 50.—One female, Shasta Co., Cal.

Caterva elegantaria *Hy. Edw.*, Papilio, Vol. I, p. 121.—Male and female, Prescott, Arizona.

Gorytodes personaria *Hy. Edw.*, Papilio, Vol. I, p. 120.—One male, Sierra Nevada, Cal.

PYRALIDÆ.

Prorasea lepidalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 146.—One male, Colorado.

Prorasea brunneogrisea *Hy. Edw.*, Ent. Am., Vol. II, p. 171.—One male, Prescott, Arizona.

Aglossa electalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 146.—One example, Arizona.

Chalcœla gemmalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 148.—One example, Sierra Nevada, Cal.

Emprepes magnalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 147.—One female, Arizona.

Botys uxorcualis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, Sierra Nevada, Cal.

Botys bellulalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 149.—One example, Texas.

Botys psychicalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 149.—One example, Texas.

Botys roseopennalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 148.—One example, Arizona.

Botys pergivalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 151.—One female, Arizona.

Botys fumoferalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, Sierra Nevada, Cal.

Botys monulalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, Sierra Nevada, Cal.

Botys thallophilalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 154.—One female, California.

Botys scurralis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 155.—One female, Arizona.

Botys festalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One female, Prescott, Arizona.

Botys lulualis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 150.—One female, Soda Springs, Cal.

Botys succandidalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, Texas.

Botys octosignalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 153.—One example, California.

Botys levalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 152.—One specimen, Florida.

Botys penitalis *Grote*, Can. Ent., Vol. VIII, p. 98.—One female, Kansas.

Botys unifascialis *Pack.*, Ann. Lyc. Nat. Hist., N. Y., Vol. X, p. 261.—One example, California.

Eurycreon aureolalus *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 156.—One female, Colorado.

Orobena reluctalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 156.—One example, Arizona.

Glyphodes alitalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 157.—One example, Indian River, Florida.

Metrea ostreonalis *Grote*, Papilio, Vol. II, p. 73.—One female, Connecticut.

Metrea argentalis *Hy. Edw.*, Papilio, Vol. IV, p. 19.—One example, Jalapa, Mexico.

Hydrocampa gyralis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 159.—One example, Georgia.

Tetralophus atrifascialis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 73.—One example, Indian River, Florida.

Nephoteryx lallatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 161.—One example, Florida.

Nephoteryx bifasciella *Hulst*, Ent. Am., Vol. III, p. 132.—One example, Arizona.

Megaphycis edwardsialis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 163.—One female, Nevada.

Acrobasis alatella *Hulst*, Ent. Am., Vol. III, p. 135.—One example, Napa Co., Cal.

Acrobasis hystriculella *Hulst*, Ent. Am., Vol. III, p. 135.—One female, Texas.

Spermatophthora montinatatella *Hulst*, Ent. Am., Vol. III, p. 134.—One example, Sierra Nevada, Cal.

Mylois zelatella *Hulst*, Ent. Am., Vol. III, p. 136.—One example, New York.

Mylois aliculella *Hulst*, Ent. Am., Vol. III, p. 135.—Male and female, Arizona.

Stenoptycha pallulella *Hulst*, Ent. Am., Vol. III, p. 137.—One example, North Carolina.

Ephestia opalescella *Hulst*, Ent. Am., Vol. III, p. 138.—One example, California.

Anerastia electella *Hulst*, Ent. Am., Vol. III, p. 137.—One male, Texas.

Crambus biothanatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 166.—One example, California.

Crambus comptulatalis *Hulst*, Trans. Am. Ent. Soc., Vol. XIII, p. 167.—One example, Vancouver Island.

PTEROPHORIDÆ.

Lioptilis grandis *Fish*, Can. Ent., Vol. XIII, p. 141.—One example, California.

Ædemataphorus gratiosa *Fish*, Can. Ent., Vol. XIII, p. 73.—One male, Sierra Nevada, Cal.

Ædemataphorus lugubris *Fish*, Can. Ent., Vol. XIII, p. 140.—One female, California.

Platyptilis edwardsii *Fish*, Can. Ent., Vol. XIII, p. 72.—Male and female, Boston, Mass.

Article XIV.—THE GEOGRAPHICAL DISTRIBUTION OF NORTH AMERICAN MAMMALS.¹

By JOEL ASAPH ALLEN.

(*With Four Maps, forming Plates V-VIII.*)

INFLUENCES DETERMINING THE GEOGRAPHICAL DISTRIBUTION OF LIFE.

It has long been recognized that the influences determining the distribution of life over the earth's surface are climate and the interrelation of the principal land areas. It is questionable which of the two, all things considered, has been the more important factor in bringing about the present distribution of life, since the climate of any given area depends largely upon the relative distribution of land and water, and is further greatly modified by the topography of the principal land areas, the presence or absence of lofty mountain chains greatly modifying the climate of an entire continent.

CLIMATE.—Of strictly climatic influences, temperature is by far the most important, although moisture plays an influential part. Where a low temperature prevails life, both animal and vegetable, is represented by comparatively few forms ; under a high temperature it is characterized by great diversity and luxuriance. Within the Arctic Circle the species of both plants and animals are not only few but they are widely distributed, being for the most part everywhere the same. Under the tropics they are a hundred fold more numerous and of comparatively restricted distribution, the general facies, as regards both the fauna and the flora, changing within short distances, with few elements in common when widely separated areas are compared.

The influence of temperature is perhaps most strikingly displayed in the distribution of life upon the slopes of a high mountain, especially if situated near the tropics. While its base may be clothed with palms and luxuriant tropical vegetation its sum-

¹ Read before the New York Academy of Sciences, January 26, 1891. In revising for publication some new matter has been added, chiefly in the last third of the paper and in the footnotes.

mit may be snow-capped and barren, or scantily covered with only a small variety of hardy alpine shrubs and plants. The animal life becomes likewise correspondingly changed, tropical forms of mammals, birds and insects of the lower slopes gradually giving place to such as are characteristic of arctic latitudes.¹

The influence of moisture is most strikingly shown in the distribution of forest trees, where on the same continent, under corresponding parallels of latitude, and at nearly the same elevation, the country may be either heavily or only sparsely wooded, or even wholly devoid of a forest growth, in accordance with the abundance or scarcity of the rain-fall. We may thus have, on the same continent, immense areas of forest alternating with vast stretches of open prairies and plains, or even almost verdureless deserts. The effect of humidity upon plant life is thus obvious; but it is equally potent, though less evident, upon animal life. Many animals—mammals and birds as well as insects—are so fitted for a forest life, as regards both food and shelter, that their very existence depends upon such surroundings. Others are equally specially adapted for life on the open plains, or even in arid deserts. Thus moisture alone may determine the character of life over extensive regions, regardless of temperature, which under ordinary conditions is the ascendant controlling influence.

INTERRELATION OF LAND AREAS.—The relation of the principal land areas to each other, in respect to continuity on the one hand and isolation on the other, is coëval and perhaps more than coördinate with climate in its influence upon the distribution of life, as it is also in the evolution of life. Palæontology teaches us that the present characteristics of the faunas and floras of the principal land areas are the results of a long period of evolution, during which there have been no very sudden transitions, but, in general, a gradual development from ancestral forms having about the same geographical distribution as their descendents. While some of the continents have unquestionably derived part of their life from neighboring continents, and islands from the mainland to which they are contiguous, these

¹ An excellent illustration of the influence of temperature upon the distribution of life on mountain slopes is afforded by Dr. C. Hart Merriam's thorough survey of the San Francisco Mountain region in Arizona, the life-zones of which he has defined and illustrated in detail. (See *N. Am. Fauna*, No. 3, Sept., 1890, pp. 5-20, pls. 1, 2, and maps 1-4.)

migrations are in the main of great antiquity, dating back at least nearly to the Miocene. At that early time, and also previously, there was not only a greater uniformity of climate, but a more uniform distribution of life. With the coming in of the Glacial Period a great change was wrought in respect to both, and the former equilibrium in neither has been restored. While it would lead me too far from the subject especially in hand to discuss at any length the probable geographical origin of the leading types of even the present mammalian life of North America, it seems well to recall, in the present connection, certain facts of general import. In the first place, the so-called Old World is admittedly the most advanced and the most specialized of the several continents, as regards both its physical features and its biology; and that probably many of its present leading types of mammalian life are of American origin; that North America is behind Eurasia in development, and South America behind North America; and that in reality Australia is the old continent in the sense of being behind all the others in its development, and thus the lowest, the least specialized, the most primitive.

In regard to the present distribution of the mammals of North America and their faunal relationship to the mammalia of the rest of the world, it is important to recall the present close proximity of North America at the northward to the northern portion of the Old World. Alaska is separated from Siberia by a shallow strait of less than forty miles in width, while in Tertiary times it is supposed they may have been united. Three-fourths of the land area is not only situated north of the equator, but is mainly massed about the northern pole, the only extensive stretch of sea being the few hundred miles between Iceland and Norway. If now we bear in mind the close similarity in climate and general physical conditions of the northern half of the northern hemisphere, its comparatively low temperature and meagre fauna and flora as compared with the tropics, and that continuity of land area tends to uniformity of life, and divergence and isolation tend to diversity of life, and increase of temperature to abundance and variety, the generalizations about to follow respecting the life regions of North America will, I trust, be recognized as resting on a sound basis.

IMPORTANCE OF MAMMALIA AS A BASIS FOR THE CLASSIFICATION OF LIFE AREAS.

First, however, a word in reference to the class *Mammalia* as a basis for the distribution of the earth's surface into ontological divisions. On this point I cannot do better than to summarize the argument made by Mr. A. R. Wallace in his great work on 'The Geographical Distribution of Animals,' simply premising that his presentation of the case has my hearty approval.

The *mammalia*, he affirms, are pre-eminently of the greatest importance in determining zoölogical regions. Their dispersal is less dependent on fortuitous circumstances than that of the representatives of other classes; from their high organization they are less dependent upon other groups of animals, and have so much power of adaptation that they are able to exist in one form or another over the whole globe, as is certainly not the case with two of the lower classes of vertebrates, the *reptilia* and *amphibia*. Their distribution and dispersal are dependent on the distribution of the land areas, and are modified by such physical conditions as mountain barriers, areas of forest, and grassy or desert plateaus. Furthermore, their geological history, as well as their geographical range, is better known than that of most other classes, and there is also a greater unanimity of opinion respecting their natural affinities and the limitation of families and genera. "We should therefore," says Mr. Wallace, "construct our typical or standard Zoölogical Regions in the first place, from a consideration of the distribution of *mammalia*, only bringing to our aid the distribution of other groups to determine doubtful points. Regions so established will be most closely in accordance with these long-enduring features of physical geography, on which the distribution of all forms of life fundamentally depend; and all discrepancies in the distribution of other classes of animals must be capable of being explained, either by their exceptional means of dispersion or by special conditions affecting their perpetuation and increase in each locality. If these considerations are well founded, the objections of those who study insects or molluscs, for example,—that our regions are not true for their departments of nature—cannot be maintained. For they will find, that a careful consideration of the exceptional means of dispersal and conditions of existence of each

group, will explain most of the divergences from the normal distribution of higher animals."¹

While the divisions of North America, as set forth in the present paper, are presented from the standpoint of mammals, it may be premised that many of them were first outlined on the basis of the distribution of birds, and that they have been found equally applicable to reptiles and bratrachians, and also in a measure to insects and plants.²

SYSTEMATIC CLASSIFICATION OF LIFE AREAS.

In zoö-geography it is customary to recognize faunal areas belonging to several different categories, as regards their grade and extent, just as in zoölogy we divide animals into classes, orders, families, genera, and species. Unfortunately, however, the terms employed for their designation have not been used with the same precision as in zoölogical terminology. Identical terms have sometimes been used in diametrically opposite senses, in accordance with each writer's individual preferences, regardless of their prior use in a different sense by other authors. In view of this unfortunate state of affairs I attempted, in a paper on the distribution of North American birds, published in 1871,³ to devise a system of terms that, while appropriate, should at the same time be in as close conformity as possible with current usage. Previously the terms *zone*, *realm*, *region*, *kingdom*, *province*, and even *fauna*, had been used more or less interchangeably for even the primary subdivisions, while some of these terms were also frequently employed in a narrower and more special sense. The scheme then proposed is as follows :

For divisions of the first rank	.....	<i>Realm.</i>
"	" second "	..... <i>Region.</i>
"	" third "	..... <i>Province.</i>
"	" fourth "	..... { <i>Subprovince</i> or <i>District.</i>
"	" fifth "	..... { <i>Fauna,</i> <i>Flora.</i>

¹ Geogr. Dist. Anim., Vol. I, pp. 56-58.

² Since this was written Dr. C. Hart Merriam, in his admirable presidential address, entitled 'The Geographic Distribution of Life in North America with Special Reference to the Mammalia,' read before the Biological Society of Washington, February 6, 1892 (Proc. Biol. Soc. Wash., Vol. VII, April, 1892, pp. 1-64), has given a 'Historical Synopsis of Faunal and Floral Divisions Proposed for North America' (I. c., pp. 6-21) which may be profitably consulted in the present connection.

³ On the Mammals and Winter Birds of East Florida, with... a Sketch of the Bird Faunæ of Eastern North America. Bull. Mus. Comp. Zool., Vol. II, No. 3, April, 1871.

Their grade and order of sequence may be indicated by a comparison with the leading groups in zoölogy: thus *realm* would correspond in rank with *class*; *region* with *order*; *province* with *family*; *district* with *genus*; and *fauna* (or *flora*, as the case may be) with *species*. It sometimes becomes convenient, as we shall see later, to recognize other divisions intermediate to those above named—as in zoölogy we have suborder⁹, subfamily, subgenus, etc., so we may have here subregions, subprovinces, and even subfaunæ. There may also be a subdivision of a continental or other large area into zones.

Temperate North America forms a *region* of the *North Temperate Realm*, and includes two *subregions*, one of which is divisible into two *provinces*; each *province* is separable into two *subprovinces* and these again into several lesser well-marked areas termed *faunæ*, as will be presently shown in detail. Realms are sometimes characterized by the presence of certain orders, commonly by the presence of certain families, which give to the region a particular impress, and by the absence of others which in a similar way characterize other realms. Regions are usually characterized by the prevalence over them of certain genera, or even by entire families; provinces by the presence or absence of prominent generic types. Faunæ, on the other hand, are seldom characterized by the presence or absence of particular genera or species but by the association, through the overlapping of their habitats, of a number of genera and species not elsewhere found together.

The transition between faunæ, between provinces, or between adjoining divisions of any grade is rarely abrupt; it is impossible to draw a hard-and-fast line between any of them; yet in a general way they may be limited with considerable definiteness. They depend upon climatic conditions, which, in a measure, are determined or modified by features of topography. They are of course limited and determined by the same conditions that govern the distribution of species. Hence we can seldom bound our faunal areas by geographical meridians or by parallels of latitude, and very rarely are they found to agree with any political boundaries; they do, however, closely coincide with certain isothermal lines, which are generally those of the season of reproduction, or, in

the northern hemisphere, those for the months of May, June and July. As temperature is influenced by altitude as well as by latitude, elevated plateaus and mountain ranges deflect the isotherms in the northern hemisphere far to the southward of their position over the contiguous low country, and furnish congenial habitats for northern forms of life under comparatively low latitudes. Thus in eastern North America the Appalachian Highlands carry the fauna of northern New England southward along the higher parts of the Alleghanies as far as northern Georgia. In the Rocky Mountains boreal types extend far down into Mexico, and along the Cascade and Sierra Nevada chain to southern California, with insular patches of northern life on the summits of detached peaks and ranges throughout the Plateau and Great Basin regions of the West. There is thus an interdigitation of the northern and southern life areas throughout the middle and southern portions of the North American continent.

The life of the globe is everywhere closely linked together. While the relationship at the northward is obviously intimate, and while in general the life of the intertropical zone is very different from that of the arctic or even of the temperate zones, and that of tropical America is very unlike that of tropical Africa or India, yet certain types are common to the whole. For example, the Cat family is represented throughout all countries except Australia, but there is a great difference between the Cats of the colder zones and those of the equatorial regions; yet the genus *Felis*, taken in a broad sense, is almost cosmopolitan. The Dog family, embracing the Wolves and Foxes, has an even wider distribution. The family Mustelidæ, embracing the Otters, Badgers, Skunks, Sables, Weasels, Minks and Martens, is more restricted, some of its leading forms, however, having a much wider and a very different distribution from others. Thus the Otters (subfamily Lutrinæ) are nearly cosmopolitan, while the true fur-bearing animals (subfamily Mustelinæ) are distinctively northern and circumpolar; the Skunks (subfamily Mephitinæ), on the other hand, are exclusively American, and range over the temperate and tropical portions of both continents. The order Insectivora has no representatives in either South America or Australia; the Hedghogs, forming a family of the order, are exclusively an Old

World type ; the Shrews, forming a second family, have a circum-polar distribution, the genus *Sorex* ranging on both continents from the Arctic regions to within the tropics. The Moles, forming a third family of this order, are confined to the north temperate latitudes, and are represented by different and peculiar genera in Europe, Asia, Africa and North America, and in the latter continent are confined mainly to the United States east of the Great Plains. Among Rodentia the genus *Sciurus*, consisting of the true or arboreal Squirrels, the genus *Sciuropterus*, or the Flying Squirrels, and the genus *Lepus*, embracing the Hares and Rabbits, are other examples of wide-ranging genera, the arboreal Squirrels and the Hares occurring everywhere except in Australia, although both are sparingly represented in America south of the Isthmus of Panama, beyond which the Flying Squirrels wholly cease to exist. But the species are generally of local distribution, and to some extent different styles of Squirrels and Hares characterize different areas of the common habitat of the group. Northern North America has several genera of Field Mice which are also common to the northern parts of the Old World, but the great bulk of our native Rats and Mice belong to genera peculiar to America. Also our Jumping Mouse, the numerous species of Kangaroo Rats and Pocket Mice, all the Pocket Gophers and the Prairie Dogs are distinctively North American.

These few illustrations, from the many that might be given, will serve to indicate, in a general way, the basis on which the life areas of North America, and of the world at large, are founded.

PRIMARY LIFE REGIONS.

Seven primary life regions, speaking of the world as a whole, may be recognized, as follows :

1. An *Arctic Realm*, occupying the region north of the isotherm of 32° F., its southern boundary conforming very closely to the northern limit of trees. Its more characteristic terrestrial forms of both animal and vegetable life range nearly throughout its extent. It is thus so homogeneous in its ontological characters as not to require subdivision into regions and provinces, though embracing several slightly-marked areas of the rank of faunæ.

2. A *North Temperate Realm*, embracing the whole of that portion of the northern hemisphere embraced between the annual isotherms of 32° and 70° F.

3. An *American Tropical Realm*, consisting, as the name implies, of tropical America.

4. An *Indo-African Realm*, consisting of Africa (except the northern border), and tropical Asia and its outlying tropical islands.

5. A *South American Temperate Realm*, embracing extra-tropical South America.

6. An *Australian Realm*, including not only the continent of Australia but New Guinea, New Zealand, and the various groups of islands to the northward and eastward.

7. A *Lemurian Realm*, consisting of Madagascar.

An eighth or *Antarctic Realm* is also often recognized. It is almost wholly oceanic, and its fauna hence consists almost exclusively of marine or pelagic species, and is of course the Antarctic counterpart of the Arctic Realm, though perhaps less well characterized.

NORTH TEMPERATE REALM.

The North Temperate Realm is divisible primarily into two Regions, namely, (1) a *North American Region*, occupying the whole of North America from the beginning of forest vegetation southward to about the northern limit of palms, or the area between the annual isotherms of 32° and 70° F.; and (2) an *Eurasiatic Region*, consisting of the corresponding portion of the Old World.

This region, and the Old World in general, lying outside of the special scope of the present paper, we will now pass to a detailed consideration of the mammalian fauna of North America, and the principal faunal subdivisions of the North American Continent, their distinctive characteristics, their relation to each other, and to the Eurasiatic Region.

Attention has already been directed to the intimate geographic relation of northern North America to northern Eurasia, and the

Genera of Land Mammals of the North Temperate Realm.

[NOTE.—The names of circumpolar genera are in *italics*; those of genera peculiar respectively to the North American and Eurasiatic Regions are in SMALL CAPS.]

NORTH AMERICAN REGION.			EURASIATIC REGION.		
Genera.	Subregions.		Genera.	Subregions.	
	Cold Temp.	Warm Temp.		Cold Temp.	Warm Temp.
<i>Didelphys</i>	—	+	<i>Sus</i>	+	—
<i>Dicotyles</i>	—	+	CAMELUS	—	+
<i>Canis</i>	—	+	MOSCHUS	+	+
<i>Cervus</i>	+	—	<i>Cervus</i>	+	+
<i>Alces</i>	+	—	<i>Alces</i>	+	—
<i>Rangifer</i>	+	—	<i>Rangifer</i>	+	—
ANTILOCAPRA	—	+	DAMA	—	+
<i>Bison</i>	+	+	CAPREOLUS	+	+
<i>Ovis</i>	+	—	ELAPHODUS	—	+
MAZAMA	+	—	HYDROPOTES	—	+
<i>Arctomys</i>	+	+	<i>Bison</i>	+	—
CYNOMYS	—	+	POEPHIAGUS	—	+
<i>Tamias</i>	+	+	ADDAX	—	+
<i>Spermophilus</i>	+	+	Oryx	—	+
<i>Sciurus</i>	+	+	Gazella	—	+
<i>Sciuropterus</i>	+	+	SAIGA	—	+
APLODONTIA	+	—	PANTHOLOPS	—	+
<i>Castor</i>	+	+	RUPICAPRA	+	—
FIBER	+	+	BUDORCAS	—	+
<i>Cuniculus</i>	+	—	Nemorhædus	+	+
<i>Myodes</i>	+	—	Capra	+	+
SYNAPTOMYS	+	+	<i>Ovis</i>	+	+
<i>Eutamias</i>	+	—	Equus	—	+
<i>Arvicola</i>	+	+	<i>Castor</i>	+	—
PEROMYSCUS	+	—	<i>Sciurus</i>	+	+
ONYCHOMYS	—	+	<i>Sciuropterus</i>	+	+
Sitomys	+	+	Pteromys	—	+
Reithrodontomys	—	+	<i>Tamias</i>	+	—
Sigmodon	—	+	<i>Spermophilus</i>	+	—
Oryzomys	—	+	<i>Arctomys</i>	+	—
Neotoma	—	+	MYOXUS	—	+
THOMOMYS	—	+	ELIOMYS	+	+
GEOMYS	—	+	MUSCARDINUS	—	+
PEROGNATHUS	—	+	Mus	+	+
MICRODIPODOPS	—	+	Gerbillus	+	+
DIPDOMYS	—	+	CRICETUS	+	+
PRODIPUS	—	+	Meriones	—	+
ZAPUS	+	+	SMINTHUS	+	—
ERETHIZON	+	—	<i>Arvicola</i>	+	+
<i>Lagomys</i>	+	—	<i>Eutamias</i>	+	—
<i>Lepus</i>	+	+	<i>Cuniculus</i>	+	—
ANTROZOUS	—	+	<i>Myodes</i>	+	—
<i>Vesperugo</i>	+	+	ELLOBIUS	+	—
NYCTICEJUS	—	+	SIPHNEUS	+	—

NORTH AMERICAN REGION.			EURASIATIC REGION.		
Genera.	Subregions.		Genera	Subregions.	
	Cold Temp.	Warm Temp.		Cold Temp.	Warm Temp.
<i>Atalapha</i>	+	+	SPALAX.....	+	—
<i>Plecotus</i>	—	+	Rhizomys.....	—	+
<i>Vespertilio</i>	+	+	Dipus.....	—	+
EUDERMA.....	—	+	Alactaga.....	+	+
Molossus.....	—	+	PLATYCERCOMYS.....	+	—
Nyctinomus.....	—	+	Hystrix.....	—	+
Otopterus.....	—	+	Lagomys.....	+	—
<i>Sorex</i>	+	+	<i>Lepus</i>	+	+
NOTIOSOREX.....	?	+	Rhinolophus.....	—	+
BLARINA.....	—	+	TRIENOPUS.....	—	+
SCALOPS.....	—	+	SYNOTUS.....	—	+
SCAPANUS.....	—	+	<i>Plecotus</i>	—	+
CONDYLURA.....	+	+	<i>Vesperugo</i>	+	+
<i>Urotrichus</i>	—	+	Harpiocephalus.....	—	+
<i>Ursus</i>	+	+	<i>Vespertilio</i>	+	+
Procyon.....	+	+	Miniopterus.....	—	+
BASSARISCUS.....	—	+	RHINOPOMA.....	—	+
<i>Lutra</i>	+	+	<i>Nyctinomus</i>	—	+
MEPHITIS.....	+	+	Erinaceus.....	+	+
Conepatus.....	—	+	<i>Sorex</i>	+	+
SPILOGALE.....	—	+	CROSSOPUS.....	+	—
TAXIDRA.....	+	+	Crociodura.....	—	+
<i>Gulo</i>	+	—	ANUSOREX.....	—	+
<i>Lutreola</i>	+	+	DIPLOMESODON.....	—	+
<i>Putorius</i>	+	+	CHIMARROGALE.....	—	+
<i>Mustela</i>	+	—	NECTOGALE.....	—	+
UROCYON.....	—	+	MYOGALE.....	—	+
<i>Vulpes</i>	+	+	<i>Urotrichus</i>	—	+
<i>Canis</i>	+	+	UROPILUS.....	—	+
<i>Lynx</i>	+	+	SCAPTONYX.....	—	+
<i>Felis</i>	—	+	TALPA.....	—	+
			SCAPTOCHIRUS.....	—	+
			<i>Ursus</i>	+	+
			ÆLUROPUS.....	—	+
			ÆLURUS.....	—	+
			MELES.....	+	+
			MELLIVORA.....	—	+
			ARCTONYX.....	—	+
			<i>Lutra</i>	+	+
			<i>Gulo</i>	+	—
			<i>Lutreola</i>	+	+
			<i>Putorius</i>	+	+
			<i>Mustela</i>	+	—
			NYCTEREUTES.....	—	+
			<i>Vulpes</i>	+	+
			CYON.....	—	+
			<i>Canis</i>	+	+
			Hyæna.....	—	+
			Genetta.....	—	+
			Herpestes.....	—	+
			<i>Lynx</i>	+	+
			<i>Felis</i>	+	+
			Macacus.....	—	+

similarity of the climatic conditions of the two regions; and to the corresponding similarity in their mammalian life, as well as of their general faunal and floral facies.

In this connection it will be instructive to compare somewhat in detail the land mammals of the North American and Eurasiatic Regions, that is, omitting the Seals and the Sea Otter. We will also exclude the strictly Arctic genera—*Ovibos* and *Thalassarctos*. With these restrictions we have 75 genera for the North American Region and 97 for the Eurasiatic Region. These are enumerated in the accompanying table, where they are divided into four categories, as follows: (1) North American, subdivided into (*a*) Cold Temperate, (*b*) Warm Temperate; (2) Eurasiatic, subdivided into (*a*) Cold Temperate, and (*b*) Warm Temperate. By the use of distinctive type, the circumpolar genera and the genera peculiar respectively to the two Regions are distinguished from those having a more or less wide distribution to the southward of the North Temperate Realm. (See pp. 208, 209.)

The total number of genera tabulated is 140, a number of genera which barely enter the southern portion of the area under consideration being excluded as not properly pertaining to it. Of these 140 genera 75 are found in North America and 97 in Eurasia, the Eurasiatic Region, as would be expected from its much larger and more diversified area, having considerably the larger number. Of these 32 are circumpolar, and thus are common to the two regions, while quite a number of others are closely-allied representative genera. Thus nearly one-half of the North American genera are either identical with or closely related to Eurasiatic genera, while only a little more than one-third of the total number are respectively peculiar to one or the other of the two regions, namely: for the North American 27 out of 75, and for the Eurasiatic 40 out of 97, or 67 out of a total of 140.

. If we compare, however, the Cold Temperate Subregions of the two Regions we find that out of 43 genera characteristic of the Cold Temperate Subregion in North America 32, or about three-fourths, are circumpolar, and that of the 49 genera of the Cold Temperate Subregion of the Eurasiatic Region 32 are also of course circumpolar. We find further that in the North American Region 17 out of the 27 peculiar genera do not extend north of

the Warm Temperate Subregion ; that 6 are common to both subregions, while 4 are peculiar to the Cold Temperate Subregion. Also that in the Eurasiatic Region 30 of the 40 peculiar genera are confined to the Warm Temperate Subregion, that 4 are common to both subregions, while 6 only are peculiar to the Cold Temperate. Consequently the peculiar genera of the two Cold Temperate Subregions, taken together, number only 10 out of a total of 140. This shows that the chief difference between the Eurasiatic and North American Regions is confined respectively to their warm temperate subdivisions, less than one-third of their peculiar or distinctive genera occurring in their cold temperate subdivisions. It is also of interest to note that the peculiar genera of the North American Region belong mainly to two or three families of Rodents—particularly the Heteromyidæ and the Geomyidæ—while many of the peculiar Eurasiatic genera belong to the Talpidæ, and in each case are restricted to comparatively limited areas.

THE SCLATERIAN SYSTEM.

While these and similar facts have been given due weight by the majority of writers on zoö-geography, there has been one notable exception to which it may not be out of place in the present connection to pointedly call attention. In 1858 Dr. P. L. Sclater, the eminent ornithologist and Secretary of the London Zoölogical Society, published a memoir on the geographical distribution of birds, in which he divided the earth's surface into two primary and four secondary zoölogical regions nearly in accordance with the principal land areas. His two primary regions are equivalent respectively to the eastern and the western hemispheres; or the Old World, termed 'Palæogæa,' and the New World, termed 'Neogæa.' These primary areas were divided on the same principle into (1) a Palæarctic Region, (2) a Nearctic Region, (3) a Palæotropical Region, (4) a Neotropical Region; thus entirely ignoring the close similarity of life throughout the cold temperate and arctic regions of the globe. These divisions, as has been urged recently in their favor,¹ are *convenient* and *easy to remember*, since they are approximately equal in size, are easily defined, and

¹ Wallace, *Geogr. Distrib. Anim.*, Vol. I, pp. 63, 64.

avoid complicated boundaries. The names chosen for them have a classical appearance, are euphonious, and hence captivating. Moreover, this scheme of classification was based on a class of animals respecting which the proposer of the scheme is recognized as an eminent authority. At this time, and even for many years later, there were few special students in the field of zoölogical geography. Hence it was natural that the classification here laid down should meet with wide acceptance, particularly among English writers. Later its fallacies were exposed, and even several eminent English naturalists proposed much more rational schemes—as Huxley on the basis of birds, Günther of the British Museum on the basis of reptiles, and Blyth on general grounds, etc. Yet in 1876, Mr. A. R. Wallace, in his very useful and in many ways admirable work on the ‘Geographical Distribution of Animals,’ gave new life to the scheme by adopting it as the basis of his own classification, and attempting its defense. We may recognize this as a system based on continental areas, regardless of the actual distribution of life; and also as the Sclaterian method, in opposition to nearly all other systems, whether of botanists or zoölogists, who in general recognize that the distribution of life is in accordance with the climatic zones, in virtue of climatic influences, which the Sclaterian school consider as superficial and misleading. Like so many other misnomers, the terms ‘Palæarctic’ and ‘Nearctic,’ ‘Palæotropical’ and ‘Neotropical,’ have apparently become ineradicable, their convenience for the designation of particular geographic areas contributing to their adoption even by authors who protest against their use in their original sense.¹

¹ Dr. Packard, in writing of the ‘American Arctic Province’ in 1883, speaks emphatically on this point as follows: “We reject the term ‘Nearctic’ proposed by Mr. P. L. Sclater, and adopted by Mr. A. R. Wallace, for America north of Central America, for the reason that it seems to us an unnatural and artificial term. The fauna is essentially American north temperate, while the Arctic regions of America and Europe-Asia form a realm by itself, of much less importance, it is true, than the north temperate realm (American and Euræo-Asiatic regions), when we consider the land plants and animals, but of nearly as much importance as regards marine life. To apply the term *Nearctic* to so vast a region as the American involves the idea that the region covers an area essentially arctic in its features. It is to be hoped that the term will not be adopted by American writers, as it is not by German and French writers, and we heartily endorse Mr. J. A. Allen’s protest against the use of the term by American writers on this subject. The circumpolar or Arctic realm is a realm by itself, limited by the low degree of temperature and mainly bounded by the isothermal of 32°, and the adoption of this term will conduce, it appears to us, to clearer and more concise ideas of the geographical distribution of life on our continent.”—*Twelfth Ann. Rep. U. S. Geol. and Geog. Surv. (Hayden)*, pt. I, p. 363.

THE MAMMALS OF NORTH AMERICA CONSIDERED IN RELATION
TO THE NORTH AMERICAN REGION AND ITS SUBDIVISIONS.

Having now compared the North American Region with the Eurasiatic Region, we may proceed to an analysis of the North American Region itself. As shown by the table of distribution already given (pp. 208, 209), the North American Region is divisible into two Subregions, namely, a Cold Temperate and a Warm Temperate.¹ The most natural boundary for separating the two Subregions seems to be, in a general way, the northern limit of the successful cultivation of wheat, rye, barley, maize, peas, beans, hops, tobacco, potatoes and tomatoes, and the apple, peach and plum, or about the isothermal line of 65° F. This is approximately the boundary line separating the Alleghanian and Canadian Faunæ, as commonly recognized. The mammalian life of one of these two subregions differs vastly more from that of the other than does the mammalian life of the boreal parts of North America from that of the corresponding portions of Eurasia. The transition is, however, somewhat gradual. New elements appear near the southern boundary of the Cold Temperate, and increase in a rapidly progressive ratio as we proceed southward, while northern types fade out, and the general aspect eventually becomes radically changed.

The mammalian fauna of the Warm Temperate subdivision is found to consist of three pretty distinct elements: first, a generally diffused and more or less modified northern element, forming about one-fourth of the whole; second, a southern element, forming about another fourth; and third, an indigenous element, comprising about the remaining half. This of course is exclusive of the southward extension of purely northern forms along the various mountain ranges, which in a measure masks or obscures the general character of the fauna throughout the Rocky Mountain Plateau region.²

¹ These subdivisions were recognized by me in 1878, but rather informally, and chiefly in a tabular way. See Bull. U. S. Geol. and Geogr. Surv., IV, pp. 339-343, and *passim* in the text at p. 337.

² Dr. Merriam has already called attention to the mixed origin of the fauna and flora of the middle temperate portion of North America in his discussion of the fauna and flora of San Francisco Mountain and the Painted Desert in Arizona (North American Fauna, No. 3, Sept., 1890, pp. 20-22.).

To review briefly the leading characteristics of the region south of about the latitude of the Great Lakes, as compared with the area to the northward, we have as new elements among the Carnivores the Panther or Mountain Lion, the Bay Lynx instead of the Canada Lynx, the Gray Fox, the little Kit Fox and the Prairie Wolf, the Black-footed Ferret, the Raccoon, and the whole Skunk tribe represented by two genera and numerous species. Among the Ruminants the Prong-horned Antelope and the Bison; while the Caribou and the Moose of the north are replaced by an entirely different genus of the Deer tribe, represented by three species. Among the Rodents, we have an entirely new set of both Squirrels and Hares, and a greatly increased number of species of each; many new Field Mice, a ten-fold increase in the ground Squirrels and *Spermophiles*; also entirely new and numerously represented genera among the Field Mice, and three new families of other rodents, including some 20 to 30 species of Pocket Gophers, Kangaroo Rats and Pocket Mice. Among the Insectivores, in place of the single genus of small Shrews characterizing the northern region, we have not only new species but additional genera, and also the whole family of Moles, comprising several genera. In Bats, in place of a few straggling species which barely reach the milder parts of the high north, we have a very great increase in the number of both genera and species. We have further in the Opossum a distinctly tropical type.

Passing now down to near the southern border of this region we find still fewer northern types, but meet in their place a decidedly tropical element. In Texas, and along our southern border thence westward, we have the Armadillo, the Peccary, the Coati, the so-called Texas Civet-cat or *Cacomistle*, the Jaguar, the Ocelot, and leaf-nosed and big-eared Bats of several genera. Although the width of the continent along the 60th parallel is three times as great as it is along the 30th parallel, the number of species of mammals is probably ten times greater along the 30th parallel than it is along the 60th, and the life, so far as mammals are concerned, has become almost entirely changed, under the influence of the greatly altered climatic conditions.

As shown by the table of distribution already given (pp. 208, 209), 14 genera occur in the Cold Temperate which do not range to any extent into the Warm Temperate, namely:

Cervus,	Aplodontia,	Erethizon,
Alces,	Cuniculus,	Lagomys,
Rangifer,	Myodes,	Gulo,
Mazama,	Phenacomys,	Mustela.
Ovis,	Evotomys,	

On the other hand, 33 genera found in the Warm Temperate do not occur in the Cold Temperate, namely :

Didelphys,	Geomys,	Otopterus,
Dicotyles,	Perognathus,	Notiosorex,
Cariacus,	Microdipodops,	Blarina,
Antilocapra,	Dipodomys,	Scalops,
Cynomys,	Perodipus,	Scapanus,
Onychomys,	Antrozous,	Urotrichus,
Reithrodontomys,	Nycticejus,	Bassariscus,
Sigmodon,	Plecotus,	Conepatus,
Oryzomys,	Euderma,	Spilogale,
Neotoma,	Molossus,	Urocyon,
Thomomys,	Nyctinomus,	Felis.

The remaining 27 genera are to a greater or less extent common to both the Cold Temperate and the Warm Temperate. These genera are as follows :

Bison,	Arvicola,	Procyon,
Arctomys,	Sitomys,	Lutra,
Tamias,	Lepus,	Mephitis,
Spermophilus,	Vesperugo,	Taxidea,
Sciurus,	Atalapha,	Lutreola,
Sciuropterus,	Vespertilio,	Putorius,
Castor,	Sorex,	Vulpes,
Fiber,	Condylura,	Canis,
Synaptomys,	Ursus,	Lynx.

Hence while the two Subregions have much in common, and are thus thoroughly bound together, their differential elements are strongly marked. The 42 genera occurring in the Cold Temperate are either obviously of boreal origin, or find their nearest relationships with boreal types. Of the 62 genera occurring in the Warm Temperate Subregion, about 14 are wide ranging southern or subcosmopolitan types (some of them disappear before reaching the southern third of the subregion), 24 may be regarded as indigenous, and about 13 as of southern (tropical or subtropical) origin.

Continuing the analysis in further detail, we find that the following 28 genera of the North American Region are of either circumpolar or subcosmopolitan distribution and hence not distinctively North American, namely :

Cervus,	Castor,	Gulo,
Alces,	Evotomys,	Lutreola,
Rangifer,	Arvicola,	Putorius,
Bison,	Lagomys,	Mustela,
Ovis,	Lepus,	Vulpes,
Arctomys,	Vesperugo,	Canis,
Tamias,	Vespertilio,	Lynx,
Spermophilus,	Sorex,	Felis.
Sciurus,	Ursus,	
Sciuropterus,	Lutra,	

Only the remaining genera can therefore be considered as distinctively North American. These may be divided, according to their distribution, as follows :

Of general distribution, and thus distinctive of the North American region as a whole rather than of any particular subdivision :

Fiber,	Atalapha,
Synaptomys,	Mephitis,
Sitomys,	Taxidea.
Zapus,	

They are not, however, all evenly distributed throughout the region, *Taxidea*, for example, being absent from the southeastern States, while some of the others do not apparently extend northward beyond the middle of the Cold Temperate Subregion. On the other hand, *Musama*, *Aplodontia*, *Latax*, and the subgenus *Neurotrichus* are of such local and peculiar distribution as not to be diagnostic of any of the lesser divisions, the first two being mountain forms and another (*Latax*) strictly littoral. *Erethizon* and *Phenacomys* are distinctive of the northern subregion ; *Synaptomys* and the subgenus *Tamiasciurus* occupy a middle position, though mainly northern ; *Condylura*, though of more local distribution, is not distinctively either northern or southern.

The remaining genera (with their subgenera, which it will be convenient to use in the present connection) do not range north of the Warm Temperate Subregion, though some of them extend far beyond it to the southward. Of these the following range over the subregion at large, and are consequently distinctive of the Warm Temperate Subregion as a whole :

Cariacus,	Scapanus,
Neotoma,	Urocyon.
Neosciurus,	

The remaining genera and subgenera are of comparatively limited distribution, and may be conveniently divided into four categories. First, however, may be eliminated a number of intrusive southern forms which are properly tropical and extend only a short distance over the southern border of the Warm Temperate Subregion. These are *Tatusia*, *Dicotyles*, *Heteromys*, *Molossus*, *Nyctinomus*, and *Nasua*; the first and the last (*Tatusia* and *Nasua*), and perhaps also *Heteromys*, though occurring north of the Rio Grande on the coast of Texas, appear to be really confined to the narrow northward extension of the American Tropical Realm along the lower coast of Texas, and thus really form no part of the proper fauna of the Warm Temperate Subregion. The four categories into which the remaining genera and subgenera may be divided are (1) *northern*, (2) *southern*, (3) *eastern*, and (4) *western*. The first two include the few types that range nearly across the continent from ocean to ocean as follows :

1. *Northern*.—Taken in a strict sense, the northern half of the Warm Temperate, has not a single genus, among those peculiar to the region, which ranges across the continent. By taking into consideration wide-ranging types, which reach this region (mainly) from the northward, we have the following as coming into the present category, namely : *Tamias*, *Lutreola*, *Zapus* and *Putorius*. *Tamias* (subgenus *Eutamias*), however, extends far southward in the West.

2. *Southern*.—The genera and subgenera that fall strictly into this category are few, even if we include besides those peculiar to the region, also those barely entering the region from the southward, as follows :

Didelphys,	Sigmodon,	Otopterus,
Dicotyles,	Oryzomys,	Corynorhinus,
Reithrodontomys,	Nyctinomus,	Spilogale.

Thus the northern and southern divisions of this subregion are distinguished mainly, so far as genera having a transcontinental distribution are concerned, by the presence of a number of types in the southern which do not reach the northern, only six of which, however, are strictly transcontinental.

3. *Eastern*.—The distinctively eastern genera and subgenera are the following :

Neofiber,
Blarina,
Scalops,

Nycticejus,
Parasciurus,
Tamias.

The first of these is local and southern ; the others have a more general range.

4. *Western*.—The following list of 20 genera and subgenera are distinctively western or southwestern, only one of them (*Ictidomys*) occurring east of the Mississippi River.

Antilocapra,
Cynomys,
Thomomys,
Perognathus,
Chaetodipus,
Microdipodops,
Dipodomys,

Perodipus,
Onychomys,
Antrozous,
Euderma,
Molossus,
Notiosorex,
Eutamias,

Otospermophilus,
Ictidomys,
Xerospermophilus,
Ammospermophilus,
Bassariscus,
Conepatus.

All but two of these (*Molossus* and *Conepatus*) are indigenous to the region under consideration. *Geomys* may also be best placed here, though limited in its United States range to the plains and prairies east of the Rocky Mountains and to the coast region of the South Atlantic and Gulf States.

From the foregoing it is evident that the Cold Temperate and Warm Temperate Subregions differ greatly in respect to homogeneousness. No part of the Cold Temperate is very strongly differentiated from the rest of the subregion, whereas different parts of the Warm Temperate are found to be very unlike, even though situated under the same parallels of latitude. Hence the Warm Temperate admits of separation into two quite unlike parts, a western and an eastern, nearly on the line of the 100th meridian, while the Cold Temperate admits of no such subdivision.

THE MAJOR FAUNAL AREAS OF THE NORTH AMERICAN CONTINENT.

We are thus led to adopt the following scheme for the division of the North American continent into major faunal areas, as illustrated in the accompanying maps. First, the Arctic portion of the continent, or the region beyond the limit of arboreal vegetation, is to be assigned to the *Arctic Realm*. Second, the region

south of the Mexican tableland, and also the low eastern coast region of Mexico north into Texas (about to Corpus Christi), and the low western coast region of Mexico north about to Mazatlan, may be assigned to the *American Tropical Realm*, with which also belong the extreme southern part of the Peninsulas of Lower California and Florida. Third, the remaining and by far the greater part of the continent belongs to the *North Temperate Realm*, of which it constitutes the *North American Region*.

The North American Region is divisible into two *Subregions*, namely, a *Cold Temperate* and a *Warm Temperate*. The latter comprises two *Provinces*, a *Humid* or Eastern, and an *Arid* or Western. The Humid Province is divisible into two *Subprovinces*, namely, an *Appalachian* or Northern, and an *Austroriparian* or Southern. The Arid Province is also divisible into two *Subprovinces*, namely, a *Campestrian* or Northern, and a *Sonoran* or Southern. The Campestrian Subprovince is susceptible of division into two or three *Districts*, as the *Great Plains District*, the *Great Basin District*, and a *Pacific Coast District*. Each of these areas usually consists of two or more minor divisions or *Fauna*. (See accompanying maps, plates V-VIII.)

We will now pass in more formal review the faunal subdivisions of the North American Continent, from Region to Fauna, so far as the latter are at present clearly determinable.

THE AMERICAN ARCTIC.

If North America were isolated from the rest of the world it would be quite proper to treat the American portion of the Arctic Realm as merely a subdivision of the North American *Region*; but in view of the fact that it is really a part of a homogeneous hyperborean fauna of circumpolar distribution it seems more in accordance with general facts to consider it as a part of the Arctic Realm. The propriety of this seems especially emphasized when we consider that the "animals and plants inhabiting the Arctic regions are usually specifically identical throughout Arctic America, Greenland, and the polar parts of Eurasia and outlying islands," the "types inhabiting the Arctic Zone being few in number and uniform in character throughout

their distribution."¹ The fauna of this Arctic Zone is thus no more American than it is Europæo-Asiatic, and differs far more from that of the adjoining region to the southward, both in North America and Eurasia, than does the American arctic from the Eurasian arctic. The Arctic Realm possesses only a small number of peculiar types in proportion to its area or in comparison with the other realms situated under more favorable conditions for the development of a diversified abundance of life; yet its peculiar types are quite numerous when considered in relation to the general meagreness of the fauna in these inclement latitudes. It is especially characterized by its poverty of life, and consequently largely by negative characters—by what it lacks rather than by a high ratio of peculiar forms.

'The American Arctic'² may be divided into two areas, which may take the rank of faunæ, or perhaps more properly of sub-faunæ, in view of their slight inter-differentiation, namely: (1) the *Barren Ground Fauna*, and (2) the *Alaskan Arctic Fauna*.³

The Arctic American as a whole is characterized by being the home of the Eskimo, the Polar Bear, the Arctic Fox, the Arctic Hare, Parry's Marmot, the White Lemming, the Musk Ox, the Barren-ground Caribou, the Walrusses, and various species of Seals. Its southern boundary also forms the northern limit of nearly all of the characteristic species of the adjoining region southward, the greater part of which find their northern limit very near where the forest vegetation gives place to that of the Barren-grounds. The two faunæ into which this area appears separable are principally characterized by each having certain marine mammals along its coast not common to the other. The Alaskan Arctic has the Fur Seal, the Sea Lion, the Banded Seal, the Pacific Walrus, and the Sea Otter, neither of which occur in the region designated as the Barren Ground Fauna, which on the other hand has a few species, including the Musk Ox, not found in the Alaskan Arctic.

¹ Merriam, *Proc. Biol. Soc. Wash.*, VII, pp. 39, 40.

² The American Arctic was ranked by me in 1871 (*Bull. Mus. Comp. Zool.*, II, No. 2, p. 403) as a 'fauna' of the Arctic Realm, and termed the 'American Arctic Fauna.'

³ The Alaskan Arctic Fauna is Mr. Edward W. Nelson's Alaskan Arctic District, characterized by him in his 'Report upon Natural History Collections made in Alaska,' 1887, pp. 27-32.

THE NORTH AMERICAN REGION.

The North American Region forms two *Subregions*, namely: (1) a *Cold Temperate Subregion*, extending southward to about the mean latitude of the Great Lakes, with outlying portions extending further southward along the principal mountain systems of the continent; and (2) a *Warm Temperate Subregion*, occupying the remainder of the North American Region. The differential features of the two subregions have already been shown in the analysis of the mammalian fauna of North America (see pp. 213-215).

I. COLD TEMPERATE SUBREGION.—The Cold Temperate Subregion extends across the continent from the Atlantic to the Pacific, and from about latitude 43° northward to the limit of forest vegetation, with, however, a narrow prolongation southward along the Appalachian Highlands as far as northern Georgia, another in the interior along the main chain of the Rocky Mountains south into Mexico, and a third along the Cascade and Sierra Nevada ranges. Its southern border also sweeps to the northward, in the region of the Great Plains, so as to exclude the plains of the Saskatchewan, which belong to the Warm Temperate. It is subdivisible into two transcontinental *zones*, termed respectively the *Hudsonian* and *Canadian Zones*,¹ named from the two principal faunæ of which this subregion mainly consists. These zones correspond respectively with the Subarctic and Cold Temperate Zones of physical geographers and botanists.

The *fauna* of the Cold Temperate Subregion are the *Hudsonian* and *Carolinian* in the east, and the *Aleutian* and *Sitkan* on the northwest coast, with a series of closely-related mountain faunæ or subfaunæ in the Rocky Mountains and the Sierra Nevada, as yet not well defined.

1. *Hudsonian Fauna*.—The Hudsonian Fauna occupies a belt at the northern border of the Cold Temperate Subregion, extending from Newfoundland to and across Alaska nearly to Bering Sea. It is thus bounded on the north by the Barren Ground Fauna, and west and northwest by the Alaskan Arctic Fauna. Its southern limit may be tentatively given as the isothermal of 57° F.

¹ See Merriam, *N. Am. Fauna*, No. 5, 1891, pp. 10-12, and *ibid.*, Proc. Biol. Soc. Washington, VII, 1892, p. 24.

The Hudsonian, as thus defined, forms the northern limit of a comparatively large number of mammals dependent upon forests for food and shelter. These are apparently the Red Fox, the Timber Wolf, the Black Bear, the Canada Lynx, the Weasels, Mink, Marten, Fisher, Wolverine, and the Otter; also of the Red Squirrel, the Flying Squirrel, the Jumping and other Mice, and the Varying Hare. These all enter the Hudsonian Fauna from the southward, and range northward to about its northern border. The northern limit of these various species is not in each case coincident, some ranging more or less beyond certain others, the exact limit being determined by the peculiar needs and habits of the species, and somewhat with local conditions. Hence here, as at the boundaries of faunæ generally, the species limited by a given fauna do not all stop along one abrupt line, but gradually fade out, one after another, within, however, comparatively narrow and locally varying limits.

The Hudsonian Fauna is further characterized by forming the southern limit of several species of Seals, as the Gray, Hooded and Harp, the Barren-ground Caribou, the Tawny Lemming, and the Yellow-cheeked Meadow Mouse, which range southward over this fauna from the Arctic Realm. The Hudsonian Fauna is thus distinctively characterized by the assemblage of species just enumerated, which occur together nowhere else.

2. *Canadian Fauna.*—The Canadian Fauna, like the Hudsonian, forms a nearly transcontinental belt, with the southern border of the Hudsonian for its northern boundary. It apparently includes a small portion of southwestern Newfoundland, nearly all of the provinces of New Brunswick and Quebec, northern Ontario, the northern half of New England, northern Michigan, the northern border of Wisconsin, and northeastern Minnesota. West of Lake Superior it stretches northwestward in a broad belt to the Peace River and northern British Columbia districts of Canada. It thus extends across the Rocky Mountains nearly to the Pacific coast. Its southern border trends at first southward, reaching its most southern point in the interior in northern Michigan and northeastern Wisconsin; it then runs northwest along the border of the plains, till it nearly or quite reaches the 55th parallel, when it then descends, west of the Saskatchewan Plains, as a narrow belt

along the eastern base of the Rocky Mountains, as far as north-eastern Montana, with a further southward extension in the mountains proper. West of the Rocky Mountains it appears not to descend below the southern boundary of British Columbia, but runs southward in the mountains to an as yet undetermined limit. To the westward it is cut off from the Pacific coast by a distinctively coast belt. It has outlying insular areas in the Adirondack region of New York and on the higher crests of the Appalachian Highlands; it also forms a zone in the Rocky Mountain chain and its outlying ranges.¹

The Canadian Fauna forms the northern limit of the common Skunk, the Star-nosed Mole, the Hoary, Red and Brown Bats, the northern form of the common Striped Squirrel, the Woodchuck, and the Virginia Deer. It also forms the southern limit of the Canada Lynx, the Wolverine, Pine Marten, Moose, Caribou, Canada Porcupine, and various species of Short-tailed Meadow Mice of the genus *Phenacomys*, etc.

3. *Sitkan Fauna*.—This is the 'Sitkan District,' as defined by Mr. E. W. Nelson.² It is of limited area, being confined to a narrow strip along the Pacific coast of Alaska, extending from Bristol Bay to about the southern end of the Territory of Alaska. So far as mammals go it has very little to distinguish it from the Canadian Fauna, of which it is practically little more than a littoral district. It is characterized by a few local forms of wide-ranging species, particularly of birds, and probably of animal life in general. It is a region of heavy precipitation and overcast skies, the climatic effect of which is strongly shown in the great intensification of color which marks most of the species coming within its influence. For this reason it seems entitled to recognition as a distinct faunal area of low rank.

4. *Aleutian Fauna*.—This is the 'Aleutian District' of Mr. E. W. Nelson,³ previously termed by me the 'Aleutian Fauna.'⁴

¹ On the southern boundary of the Canadian Fauna in the East, see Verrill, *Proc. Bost. Soc. Nat. Hist.*, Vol. X, p. 260, and Allen, *Bull. Mus. Comp. Zool.*, Vol. V, p. 398. See also Dr. Merriam's Map 5 in 'North American Fauna' No. 3, where the southern boundary of his Boreal Province may be taken as the southern boundary of the Canadian Fauna.

² *Rep. Nat. Hist. Coll. made in Alaska*, 1887, pp. 24-26.

³ *Ibid.*, 1887, p. 26.

⁴ *Bull. Mus. Comp. Zool.*, II, 1871, p. 401.

It includes not only the Aleutian chain of islands, but also the western and southern portions of the Alaskan Peninsula and probably the island of Kadiak, although this may more properly belong to the Sitkan Fauna. So far as mammals are concerned there is very little to distinguish the Aleutian Fauna, but it is well characterized by its bird life.

Both the Hudsonian and the Canadian Faunæ are represented in the higher parts of the Cascades, and in the more northerly parts of the Rocky Mountains in the United States, including their outlying spurs in both Idaho and Montana. More to the southward, in Utah and Colorado, and thence further southward in New Mexico, Arizona, and in Mexico, and also in the mountains of California, a few new elements come in, the differentiation being progressive toward the southward. Our knowledge of the mammalian life of these subalpine regions is, however, still too limited to render practicable any attempt in the present connection to define or characterize these southern extensions of the Hudsonian and Canadian life zones. We are thus far indebted to Dr. C. Hart Merriam, Chief of the Division of Mammalogy and Ornithology of the Department of Agriculture, for most of the exact knowledge we at present possess on the subject, and for a very successful attempt to correlate the life zones of some of our western mountain areas with those of the northern part of the continent. In the San Francisco Mountain region in Arizona he has very clearly traced¹ seven life zones and in part correlated them with the corresponding life areas of the continent at large. He subsequently extended² his careful methods of field work to the mountains of South-Central Idaho, with like praiseworthy and satisfactory results. The zones recognized in the San Francisco Mountain region and their correlations may be indicated as follows :

<i>Zone.</i>	<i>Fauna.</i>
Alpine.....	} Arctic.
Subalpine or Timber-line.....	
Hudsonian or Spruce.....	Hudsonian.
Canadian or Fir.....	Canadian.
Neutral or Pine.....	Alleghanian.
Piñon or Cedar.....	[Carolinian].
Desert.....	[Louisianian].

¹ N. Am. Fauna, No. 3, 1890, pp. 7-34 and maps 1-4.

² *Ibid.*, No. 5, 1891, pp. 9-12, 21-25.

II. WARM TEMPERATE SUBREGION.—The Warm Temperate Subregion occupies middle North America, extending from the Cold Temperate Subregion on the north to the American Tropical Realm, as already defined, on the south. It thus includes the greater part of the United States, Lower California, and the Mexican tableland. It is cut into along the principal mountain systems by the southern prolongations of the Cold Temperate Subregion, and also extends northward over the Saskatchewan Plains. The extreme southern parts of the peninsulas of Florida and Lower California, however, are excluded, as also the lower coast region of Texas, these excluded districts, though of comparatively small extent, belonging to the Tropical Realm.

The Warm Temperate Subregion, regarded as a whole, is very unlike the comparatively homogeneous Cold Temperate Subregion, as already shown (pp. 213-218). It is vastly more varied in its physical features, is situated for the most part under climatic conditions more favorable to abundance and diversity of life, and thus presents a greater proportion of peculiar types, and also a larger number of more sharply contrasted faunal areas. Its life is largely indigenous, with, however, a strong infusion of both northern and southern elements. The indigenous elements appear to have had their origin in the Mexican plateau region, and are thus properly designated as Sonoran. The following list of mammalian genera and subgenera may be safely placed in this category :

Cariacus,	Thomomys,	Spilogale,
Antilocapra,	Dipodomys,	Notiosorex,
Cynomys,	Perodipus,	Scalops,
Xerospermophilus,	Microdipodops,	Scapanus,
Ammospermophilus,	Perognathus,	Corynorhinus,
Reithrodontomys,	Chætodipus,	Euderma,
Onychomys,	Bassariscus,	Antrozous.
Geomys,	Conepatus,	

The genera of tropical origin are :

Didelphys,	Sigmodon,	Molossus,
Dicotyles,	Neotoma,	Nyctinomus,
Oryzomys,	Procyon,	Otopterus.

Only two of these, *Neotoma* and *Procyon*, extend very far northward.

Besides the above, several genera of wide distribution beyond North America also occur, as

Lepus,	Spermophilus,	Vulpes,
Castor,	Lutra,	Lynx,
Sciurus,	Mustela,	Felis,
Sciuropterus,	Putorius,	Vesperugo,
Tamias,	Canis,	Vespertilio, etc.

Several American genera of rather extended range to the northward also occur, as *Sitomys*, *Fiber*, *Atalapha*, *Mephitis*, *Taxidea*, etc.

Nomenclature and History.—Before passing to a detailed consideration of the subdivisions of the Warm Temperate Subregion, it may be proper to refer briefly to its nomenclature and history, as treated by previous authors. This region, as here defined, consists of the southern portion of Baird's Eastern Province, together with his Middle and Western Provinces. As early as 1878¹ I separated the 'North American Region' into two *Subregions*, namely, a *Cold Temperate Subregion* and a *Warm Temperate Subregion*, as is done in the present paper, using these terms as headings in tables giving the distribution of the genera of North American Mammals. Baird's 'Eastern,' 'Middle,' and 'Western' *Provinces* were recognized as "natural regions," with the designation of 'Provinces,' but with the Eastern Province modified so as to restrict it to the Warm Temperate Subregion, and all three reduced in grade to regions of the third rank² instead of the second rank, as regarded by Professor Baird.

In 1883 Dr. Packard³ substantially adopted this classification in treating of the faunal regions of North America, with, however, a change of name for the 'Cold Temperate Subregion,' he adopting for it that of 'Boreal Province'—an unfortunate suggestion of my own made later in the paper above cited (l. c., p. 376, where, in some unaccountable way my former division of the 'North Temperate Realm' into 'Subregions' was wholly overlooked!). Dr. Packard, in his otherwise excellent 'Zoö-geographical Map of North America,' failed, however, to recognize the southward

¹ Bull. U. S. Geol. and Geogr. Survey (Hayden), IV, 1878, pp. 338-344.

² That is, of the North American Region; really of fourth rank, considered from the basis of the world as a whole.

³ Twelfth Ann. Rep. U. S. Geol. and Geogr. Survey (Hayden), pt. I, 1883, pp. 368-370, and map; the latter republished in the Third Rep. U. S. Entomol. Comm., 1883, map iv.

extension of the Cold Temperate Subregion along the principal mountain systems of the continent.

Dr. Merriam in 1890¹ again set off the Cold Temperate Subregion, under the name 'Boreal Province,' and mapped in detail its southern prolongations into the mountainous parts of the Warm Temperate. The Warm Temperate Subregion was also recognized as a contrasting region of coördinate rank, under the designation 'Sonoran Province,' while the old 'Eastern,' 'Middle,' and 'Western' Provinces were properly repudiated as having no basis in nature. . Particularly is this the case in respect to the Central Province, of which Dr. Merriam observes: "The region almost universally recognized by recent writers as the 'Central Province' is made up of the Great Plains, the Rocky Mountains and the Great Basin. A critical study of the life of the Rocky Mountains has shown it to consist of a southward extension of the Boreal Province, with an admixture of southern forms resulting from an intrusion or overlapping of representatives of the Sonoran Province, some of which, from long residence in the region, have undergone enough modification to be recognized as distinct subspecies or even species. A similar analysis of the Great Plains and Great Basin has shown them to consist of northward extensions of the Sonoran Province, somewhat mixed with the southernmost fauna and flora of the Boreal Province. Thus the whole of the so-called 'Great Central Province' disappears.

"This explains a multitude of facts that are utterly incomprehensible under the commonly-accepted zoölogical divisions of the country. These facts relate particularly to the distribution of species about the northern boundaries of the supposed Central and Pacific Provinces, and to the dilemma we find ourselves in when attempting to account for the origin of so many primary life areas in a country where there are no impassable physical barriers to prevent the diffusion of animals and plants."²

Dr. Merriam's generalizations respecting the Central Province of authors mark an important advance in the study of North American bio-geography. Taking this region with its original boundaries and significance it is a highly artificial division, em-

¹ N. Am. Fauna, No. 3, Sept. 1890, pp. 24-26, and map 5; see also Proc. Biol. Soc. Washington, VII, 1892, pp. 21-40, and accompanying map.

² N. Am. Fauna, No. 3, pp. 22, 23.

bracing within its area very unlike faunal elements. Eliminating from it, however, the broad central arm of the 'Boreal' or Cold Temperate Subregion, which occupies so much of the great central plateau, relieves it of an extraneous element, and reduces it to a more natural and geographically quite different region.

As already seen, Dr. Merriam selected for his two primary divisions of the North American Region the terms 'Boreal' and 'Sonoran' *Provinces*. These regions, both as to grade and nomenclature, were at first apparently adopted provisionally, as he says, in speaking of the United States: "Indeed, the present investigation demonstrates that there are but two primary life provinces in this country: a northern, which may be termed *Boreal*, and a southern, which, for our purposes, may be termed *Sonoran*, since it comes to us from Mexico through Sonora."¹ Later, however, he has termed these divisions 'Regions' instead of 'Provinces,' but has continued the use of the terms 'Boreal' and 'Sonoran.' The term *Sonoran* is thus applied to a region identical in geographical extent with the Warm Temperate—a designation previously used for the same area—and hence includes the whole region east of the Mississippi (as well as that west of it), from the Great Lakes and southern New England south to Florida and the Gulf Coast. The terms 'Sonoran' and 'Sonoran Province' were used, however, as early as 1866 by Prof. Cope,² and also later by Cope, Heilprin, and others, for a region of comparatively small extent, consisting of Sonora and adjoining portions of Arizona and New Mexico. In 1887 Heilprin³ extended the region to include "the peninsula of Lower California, the State of Sonora in Mexico, New Mexico, Arizona, and parts, not yet absolutely defined, of Nevada, California, Texas, and Florida," and modified its title by calling it the 'Sonoran Transition Region.' The Sonoran Province or Region of these authors is thus not at all the 'Sonoran Region' of Merriam, which is an area of much greater extent and of higher rank. The term *Sonoran*, used in this extended sense, seems at least inappropriate if not misleading, as there are few if any strictly 'Sonoran' types represented in that portion of the United States

¹ *N. Am. Fauna*, No. 3, p. 19.

² *Proc. Acad. Nat. Sci. Phila.*, 1866, p. 300.

³ *The Geogr. and Geol. Distrib. of Anim.*, p. 106.

situated to the eastward of the Mississippi River. The more descriptive and appropriate designation of 'Warm Temperate' is therefore preferred for the region in question, since it not only has priority but is in harmony with the terms Arctic, Cold Temperate, and Tropical, used currently for other coördinate areas of the continent.

Dr. Merriam in his important contributions to North American bio-geography has evidently not attempted to devise a systematic scheme of terminology and classification for the various grades of faunal areas, but, at first at least, simply employed provisionally such terms as would suffice to clearly indicate the regions under consideration, his attention being mainly and most successfully given to an elucidation of the facts of distribution. In following out, in the present connection, a consistent scheme of nomenclature, first attempted many years ago, the aim is to fix definitely designations for areas of different grades, and to combine the whole into a consistent system of classification. The nomenclature of the subject has ever been in such a chaotic and inharmonious state that a strict 'rule of priority' cannot be enforced, the same terms having been used in widely different senses, while not unfrequently a number of different names have been given to the same area. As already explained (p. 204) the system here proposed in respect to the *rank* of areas of different grades, as from Realm to Fauna, is analagous to the systematic schemes of classification in biology, and also in stratigraphic geology. The selection of distinctive names for divisions of the higher grades has relation to the influences controlling the geographic distribution of life, namely, *climate*, and hence it is natural that the climatic zones and their principal subdivisions should suggest the names of many of the major ontological areas. This indeed has been the custom to a large extent with both botanists and physiographers, and has often been practiced by zoölogists. Thus 'Humid' and 'Arid' become appropriate and suggestive designations for the eastern and western subdivisions of the North American Warm Temperate Subregion. For the lesser regions geographical names, as 'Hudsonian,' etc., are admirably appropriate when suggestive of some characteristic portion of the region in question. Whenever feasible, names first given should of

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² *Proc. Acad. Nat. Sci. Phila.*, 1866, p. 300.

³ *The Geogr. and Geol. Distrib. of Anim.*, p. 106.

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course be retained in preference to later names. Furthermore, the terms indicative of grade should be used with the same uniformity and strictness as are the terms order, family, genus, etc., expressive of rank, in biology.

PROVINCES OF THE WARM TEMPERATE.—The Warm Temperate Subregion, considered as a whole, is primarily divisible into two *Provinces*, namely, (1) a *Humid Province*, extending from the Atlantic Coast to the vicinity of the 100th meridian, and (2) an *Arid Province*, extending from the western border of the Humid Province to the Pacific coast, excluding of course all the higher mountain ranges, which are more or less wooded and constitute southern extensions of the Cold Temperate Subregion.

The Humid Province, as the name implies, has a humid climate and is in general heavily forested; the Arid Province is a dry region, some of it excessively arid, and consists mainly of open plains and deserts. It is highly diversified in respect to its physiographic features, and presents consequently a more varied fauna than is met with in the Humid Province. As already shown (p. 218) these two provinces are distinguished by the occurrence in each of a few peculiar types not possessed by the other, the Arid Province, however, having by far the greater number of peculiar types, owing to the large continuous land area extending from its southern boundary southward, from which direction much of its life has been derived, while the Humid Province has for its southern boundary a wide expanse of sea, namely, the Gulf of Mexico.

These two provinces thus coincide with the two strongly-marked climatic divisions of the middle, or United States, portion of North America in respect to rain-fall. Unlike the major divisions heretofore characterized (realms, regions and subregions), and also unlike the transcontinental zones, they are not separated by isothermal lines, trending in an east and west direction, but by a north and south line determined by the amount of rain-fall. Thus, in the present instance, temperature as a climatic influence governing the distribution of animals and plants is subordinated to the other leading climatic influence, humidity, which varies greatly in these two contrasting regions, in consequence of the long-continued

peculiar physiographic and geographic conditions of the two regions. The many peculiar or indigenous types characterizing the Arid Province as compared with the Humid owe their existence, as already intimated, to the adjoining broad land area stretching far to the southward, whence they have been in large part derived, as contrasted with the absence of such a land area adjoining the Humid Province on its southern border. A large proportion of these peculiar types extend northward to the northern border of the Arid Province, or across the whole breadth of the Warm Temperate Subregion. The Warm Temperate Subregion is further subdivisible in a transcontinental direction into two zones, which might be termed a North Warm Temperate and a South Warm Temperate, as shown later on, but neither would be characterized by any considerable number of transcontinental genera. The northern belt would be characterized by less than half-a-dozen Cold Temperate genera which range a little way into the Warm Temperate, and the southern belt by about the same number of semi-tropical genera which extend into it from the southward. The remaining genera of the Warm Temperate are either wide-ranging transcontinental genera common to both belts, or else genera peculiar to either the Arid or the Humid Province.

The transition between the Humid and Arid Provinces is nowhere abrupt; they gradually merge into each other everywhere along their line of junction, as the prairies of the Mississippi Valley gradually become more arid and take on the characteristic aspect of the more arid plains. There is thus here the usual 'transition' belt occurring between contiguous faunal areas. It is, however, rather broader than between regions where temperature is primarily the limiting influence, as in the case of boundaries trending in a nearly east and west direction, the transition being first from a forested region to one of fertile prairies, and thence to arid plains and deserts. The dividing line may be considered as coincident with the isohyetal curve marking an annual rain-fall of 20 inches or less, as shown on rain-fall charts of the United States—hence, as above said, near the rooth meridian.

As already stated, the regions here designated as Humid and Arid 'Provinces' coincide with the 'humid' and 'arid' portions respectively of Dr. Merriam's 'Transition,' 'Upper Sonoran,' and

'Lower Sonoran' Zones ;' he thus recognizing, but in a somewhat different way, the Humid and Arid areas here classified as *Provinces*.

HUMID PROVINCE.—The Humid Province corresponds to the warm temperate part of Prof. Baird's 'Eastern Province,' and is exactly coincident with Dr. Merriam's 'Humid Sonoran' and 'Humid Transition.'¹ It comprises the United States east of the Great Plains, including also southeastern Ontario and the upper St. Lawrence Valley, but excluding northern New England, a portion of northern New York, northern Michigan and northern Wisconsin, and the higher crests of the Alleghanies. It contains a few genera and subgenera which do not occur in the Arid Province, as *Nycticejus*, *Blarina*, *Scalops*, *Condylura*, *Neofiber*, *Parasciurus* and *Tamias* (restricted subgenus). It lacks about 20 genera and subgenera that are confined in their eastward range to the Arid Province.

The Humid Province is separable into two *subprovinces*, namely, (1) an *Appalachian Subprovince*, and (2) an *Austroriparian Subprovince*.

Appalachian Subprovince.—The Appalachian Subprovince consists of the Alleghanian and Carolinian Faunæ, with the boundaries as long recognized by ornithologists and mammalogists, and as recently revised and mapped by Dr. Merriam.² It is characterized by the presence of a number of somewhat northern genera and subgenera which do not extend south of the southern boundary of the Carolinian Fauna, namely :

Arctomys,
Tamias,
Tamiasciurus,

Mynomes,
Pitymys,

Synaptomys,
Condylura.

It is further characterized by the absence of a considerably greater number of southern genera and subgenera which do not pass north of its southern border, 'as enumerated in the next paragraph.

¹ Proc. Biol. Soc. Washington, VII, pp. 27-31, and accompanying map.

² *Ibid.*, pp. 27 and 30, and accompanying map.

³ North Am. Fauna, No. 3, Map 5.

Austroriparian Subprovince.—The Austroriparian Subprovince consists of the long-recognized Louisianian Fauna, or 'Austroriparian' Fauna, as sometimes termed. Its fauna differs so much from that of the Appalachian Subprovince that they form two strongly-contrasted faunal areas. It is reached by few northern types, southern forms prevailing, to which are added genera of wide general distribution, like *Lutra*, *Canis*, *Vulpes*, *Sciurus*, *Sciuropterus*, *Lepus*, etc. It is characterized by the absence of the genera tabulated in the preceding paragraph, and by the presence of a larger number of others which do not extend north of its northern boundary, namely :

Reithrodontomys,	Neotoma,	Spilogale,
Oryzomys,	Neofiber,	Corynorhinus,
Sigmodon,	Geomys, ¹	Nyctinomys.

FAUNÆ OF THE HUMID PROVINCE.—The Humid Province, as here limited, has long been divided into three *Faunæ*, as follows : (1) *Alleghanian Fauna* ; (2) *Carolinian Fauna* ; (3) *Louisianian Fauna*. They have been so long recognized, and of late so clearly defined, that their boundaries have become well known.²

1. *Alleghanian Fauna.*—The northern border of the Alleghanian Fauna forms about the northern limit of the Panther, the Bay Lynx, the Raccoon, the Mole Shrew, the common and Brewer's Moles, the Gray Squirrel, and the Wood Hare. Its southern border forms about the southern limit of the Fisher, the Ermines, the Harbor Seal, the Elk (in former times), the Northern Striped Squirrel,³ several species of Field Mice (genera *Eutamias* and *Synaptomys*), the varying Hare, etc. It also forms the northern limit of the Cat and Fox Squirrels (subgenus *Parasciurus*), the Opossum, and various other species soon to be mentioned in characterizing the Carolinian Fauna. The Alleghanian Fauna is thus characterized by the overlapping and commingling of a particular set of species not found elsewhere associated. It is bounded on the north by the Canadian Fauna, on the south by the Carolinian Fauna, and extends westward to the edge of the Great Plains.

¹ So far as its distribution east of the Mississippi River is concerned.

² See Allen, Bull. Mus. Comp. Zool., II, pp. 395-397; Merriam, North. Am. Fauna, No. 3, map No. 5. Respecting especially the southern boundary of the Alleghanian Fauna, see Bicknell, Bull. Nutt. Orn. Club, III, p. 228; Allen, *ibid.*, p. 249; Chapman, Auk, VI, p. 279.

2. *Carolinian Fauna*.—The northern boundary of this fauna forms in a general way the northern limit of the Gray Fox, the Northern Fox Squirrels, the Pine Mouse, the Opossum, and a Bat of the genus *Nycticejus*. It also forms the southern limit of the Star-nosed Mole, the common Red Squirrel, the Southern Chipmunk, the Woodchuck, the Muskrat, and the common Meadow Mouse (*Arvicola riparius*).

3. *Louisianian Fauna*.—The Louisianian Fauna joins the Carolinian Fauna on the south, and occupies the rest of the Eastern United States to the southward, excepting the extreme southern portion of the peninsula of Florida, which has long been recognized as a *Floridian Fauna*, and as belonging to the Antillean Subregion of the American Tropical Realm. The Louisianian Fauna is characterized by the possession of a number of both genera and species not found north of its limits, although most of the Louisianian genera have a wide distribution southward in Mexico, and westward and northwestward, where, however, they are commonly represented by different species. The characteristic elements of the Louisianian Fauna are the Wood Rat, Cotton Rat, Cotton Mouse, Golden Mouse, Rice-field Mouse, Harvest Mouse, Pocket Gopher, the Southern Gray and Southern Fox Squirrels, the Marsh Hare, Swamp Hare, Little Striped Skunk, and a species each of Big-eared and Leaf-nosed Bats. These represent eight genera not found in the Carolinian Fauna, as follows: *Neotoma*, *Sigmodon*, *Oryzomys*, *Reithrodontomys*, *Geomys*, *Spilogale*, *Corynorhinus* and *Nyctinomus*.

Several interesting facts may be here noted in relation to the faunæ of the Humid Province of the Warm Temperate Subregion as compared with the eastern tier of faunæ in the Cold Temperate Subregion. While the Alleghanian, Carolinian and Louisianian Faunæ terminate at the eastern border of the Great Plains, and hence extend over less than half the width of the continent, the Canadian and Hudsonian sweep across nearly its whole breadth, from the Atlantic coast nearly to the Pacific, and this too at a point where the continent presents its greatest breadth. The mammals and birds found from about the latitude of 43° northward extend as a rule uninterruptedly northwestward from the

eastern seaboard over the comparatively low, generally forested interior to the Rocky Mountains and across Alaska almost to the Pacific coast. They also pass over the depressed portions of the Rockies in about latitude 57° to 59° , and follow the Peace and Liard Rivers to the sources of the Yukon, spreading thence northward and westward to the coast ranges of southern Alaska. In fact, the Rocky Mountains, as is well known, present too many points of depression to form much of a barrier to the dispersion of species, so that from southwestern British Columbia northward, except along the coast, the fauna is nearly identical with that of eastern Canada and northern New England. The arid, treeless plains of the interior thus form a greater barrier to the extension westward of eastern forms than do the Rocky Mountains themselves.

ARID PROVINCE.—The Arid Province extends from the eastern border of the Great Plains to the Pacific, and northward over the Saskatchewan Plains, the Plains of the Columbia, and thence north into southern British Columbia. It thus includes the so-called 'Central' and 'Pacific' Provinces of Baird and most subsequent writers, excepting of course the more elevated parts of the Rocky Mountain plateau. It is thus coextensive with Dr. Merriam's 'Arid Sonoran.' While it is true that a narrow belt along the Pacific coast from Southern California northward to the Alaskan Peninsula possesses a few peculiar types, and lacks a few of those occurring in the region immediately to the eastward, the differentiation is on the whole too slight to give to this Pacific coast district the rank of a region coördinate in grade with Baird's so-called Middle and Eastern Provinces.¹ These differences serve at best merely to mark off from the interior region at large a tier of narrow coast faunæ of the same grade as those bordering the Atlantic coast,

¹ In writing in 1871 of the 'Natural Provinces of the North American Temperate Region,' from the standpoint of Ornithology, I adopted the present classification, as shown by the following: "Within this Region may be recognized two Provinces—an Eastern and a Western—quite distinct from each other in their general features as well as in many special characteristics. The Eastern Province is characterized by the uniformity of its geographical and climatic features, and by a corresponding uniformity in its faunal and floral aspects. The Western Province, on the other hand, is characterized by the diversity of its geographical and climatic features—different areas situated under the same parallels differing greatly in these respects—and by the number and small extent of its zoological and botanical areas, and its comparatively numerous restricted flora and fauna.... The Western Region [*see* Province] commences at the western border of the Eastern and extends thence to the Pacific coast."—*Bull. Mus. Comp. Zool.*, Vol. 11, pp. 384, 385.

although the latter, owing to the widely different physiography of the eastern and western borders of the continent, have a much greater east and west extent.

The Arid Province is characterized by the presence of about 20 genera not found in the Humid Province, and by lacking a few occurring in the latter. The 20 genera and subgenera of the Arid Province not found in the Humid Province are the following:

Antilocapra,	Perodipus,	Otospermophilus,
Cynomys,	Onychomys,	Ictidomys,
Thomomys,	Antrozous,	Xerospermophilus,
Perognathus,	Euderma,	Ammospermophilus,
Chætodipus,	Molossus,	Bassariscus,
Microdipodops,	Notiosorex,	Conepatus.
Dipodomys,	Eutamias,	

Among its characteristic mammals are the Badger, Coyote, Kit Fox, Black-footed Ferret, Texas Civet Cat, the Mule and Black-tailed Deer, the Prong-horned Antelope, all of the numerous species and subspecies of the genus *Thomomys* and nearly all the species of *Geomys*, four genera and some thirty species of Kangaroo Rats and Pocket Mice, all of the several species of Prairie Dog, eight or ten species of *Spermophiles*, a dozen species of Ground Squirrels, including the whole subgenus *Eutamias*, all of the several species of Jackass Hares, all of the Grasshopper Mice (*Onychomys*), and numerous species of Bats, Shrews and Arboreal Squirrels.

Subprovinces of the Arid Province.—The Arid Province, like the Humid, is divisible into two subprovinces, namely, (1) a northern or *Campestrian Subprovince*, and (2) a southern or *Sonoran Subprovince*. These two regions correspond respectively with Dr. Merriam's 'Arid Upper Sonoran' and 'Arid Lower Sonoran'; just as the two subprovinces of the Eastern Province correspond with his 'Humid Upper Sonoran' and 'Humid Lower Sonoran,' as laid down on his 'Second Provisional Bio-geographic Map of North America,' except that the 'humid' and 'arid' portions of his 'Transition Zone' are also included respectively in the Alleghanian and Campestrian Subprovinces. The Sonoran Subprovince is equal to Dr. Merriam's restricted "Arid or Sonoran subregion proper" plus his "Lower Californian subregion," while the Campestrian Subprovince includes his "Great Basin subregion" and

his "Great Plains subregion."¹ The name 'Campestrian,' has reference to the fact that this subprovince is largely made up of plains, including as it does the greater part of the Great Plains, the Plains of the Saskatchewan, and the Plains of the Columbia and Snake Rivers. (See map, pl. VII.)

Many species are limited in their southward distribution by the southern border of the Campestrian Subprovince, but few genera appear to be thus restricted. This boundary also forms about the northern limit of many species and genera of the Sonoran Subprovince. These two subprovinces are hence characterized mainly by the presence of a large number of forms found in the Sonoran which are absent from the Campestrian, which is thus characterized, like many northern divisions when compared with adjoining southern ones of coördinate rank, from the Arctic southward, by what it lacks rather than by the possession of any peculiar types.

Districts of the Campestrian Subprovince.—The Arid Province is further divisible into a number of areas intermediate in rank between faunæ and subprovinces, which may be called *Districts*. Thus the Campestrian Subprovince is separated by the main chain of the Rocky Mountains into two areas each of which includes two or more faunæ, equivalent to and representative of the Alleghanian and Carolinian Faunæ of the Atlantic coast. These two areas are (1) the *Great Plains District*, consisting of the Great Plains region east of the Rocky Mountains from northern Texas to and including the Saskatchewan Plains; and (2) the *Great Basin District*, including the Great Basin region at large, from southern New Mexico, southern Utah, and southern Nevada north to the Plains of the Columbia and Snake Rivers, and thence northward over the more open and arid portions of eastern British Columbia. It encloses outlying spurs and insular areas of the Cold Temperate Subregion. These two districts possess few distinctive genera and but few distinctive species, though physiographically so well separated. A narrow Pacific Coast belt, situated mainly west of the Sierra Nevada and Cascade Ranges, may be recognized as (3) a *Pacific Coast District*,

¹ *Cf. N. Am. Fauna*, No. 3, p. 25.

characterized by the presence of a few species and a considerable number of subspecies mainly restricted to it. (See map, pl. VII.)

The *Sonoran Subprovince* is apparently not so distinctly separable into Districts of very marked distinctness, even the Peninsula of Lower California presenting few peculiar forms of higher grade than subspecies. Apparently, however, the main continental divide serves to separate a well-marked eastern from a well-marked western subdivision, each characterized by many species and subspecies not found in the other.

The ultimate faunal areas, or the *Faunæ*, of the Arid Province have not as yet been outlined, and their detailed treatment is beyond the scope of the present paper.

ZONES OF THE WARM TEMPERATE SUBREGION.—In addition to the subdivisions of the Warm Temperate already recognized, and independent of them, this subregion may be divided also into several *zones* or *belts* of transcontinental extent, namely, (1) *Alleghanian Zone*, (2) *Carolinian Zone*, and (3) *Louisianian Zone*—these names being based respectively on those of the long-known Atlantic coast faunæ, of which they respectively in part consist, just as 'Canadian' and 'Hudsonian' have been adopted for the transcontinental zones of the Cold Temperate.

The *Alleghanian Zone*, east of the Great Plains, consists of the Alleghanian Fauna; from the eastern edge of the Plains westward it consists of a succession of faunæ—one in the Great Plains District, another in the Great Basin District, and a third in the Pacific Coast District, as yet not clearly defined—equivalent in faunal character to and representative of the Alleghanian Fauna of the East. This zone has already been traced across the continent and mapped by Dr. Merriam under the name '*Neutral* or Transition Zone.' It was first recognized by him in his exploration of the San Francisco Mountain region in Arizona, under the name of '*Neutral* or Pine Zone,' and later

¹ Proc. Biol. Soc. Washington, VII, 1892, pp. 30-33, and accompanying map.

² N. Am. Fauna, No. 3, 1890, p. 11.

in Idaho.¹ In his later treatment of the subject he has strangely separated this zone as an independent region of minor grade, interposed between his two primary divisions of the continent ! He says : " Interposed between the Boreal and Sonoran Regions throughout their numerous windings and interdigitations, is the Neutral or Transition Zone. The humid division of this zone, known as the Alleghanian Fauna, covers the greater part of New England . . . and extends westerly over the greater part of New York, southern Ontario and Pennsylvania, and sends an arm south along the Alleghanies all the way across the Virginias, Carolinas, and eastern Tennessee, to northern Georgia and Alabama. In the Great Lake region this zone continues westerly across southern Michigan and Wisconsin, and then curves northward over the prairie region of Minnesota, covering the greater parts of North Dakota, Manitoba, and the plains of the Saskatchewan ; thence bending abruptly south it crosses eastern Montana and Wyoming, including parts of western South Dakota and Nebraska, and forms a belt along the eastern base of the Rocky Mountains in Colorado and northern New Mexico, here as elsewhere occupying the interval between the Upper Sonoran and Boreal Zones."²

The Alleghanian Zone is beyond question a transition belt, being necessarily so from its geographical position ; its affinities, however, are decidedly with the Warm Temperate division of the continent rather than with the Cold Temperate, as the case was first interpreted by Dr. Merriam,³ since its northern boundary coincides closely with the northern limit of distribution of a large number of southern genera of both plants and animals, including most of the staple grains and fruits of the Warm Temperate Zone.

As is well known, there is always a belt of neutral territory along the common boundary line of two adjoining areas, varying in breadth with the rank of the two areas ; and the present case of the Alleghanian Zone is thus not exceptional. All things considered it therefore seems best to regard it as the northern trans-continental belt of the Warm Temperate rather than to give it the

¹ N. Am. Fauna, No. 5, 1891, p. 24.

² Proc. Biol. Soc. Washington, VII, 1892, pp. 30, 31.

³ N. Am. Fauna, No. 3, p. 20, and *ibid.*, No. 5, pp. 21 and 25.

anomalous position of a minor faunal area interposed between and completely separating two areas of a higher grade.¹

The *Carolinian Zone* consists of the Carolinian Fauna, with its several western equivalents. It correlates with the 'Piñon Zone' of Dr. Merriam, as recognized by him in the San Francisco Mountain Region,² and later in Idaho, under the designation of 'Arid Upper Sonoran Zone.'³ Taken as a whole it corresponds to what he has denominated Upper Sonoran.

The *Louisianian Zone* includes the Louisianian Fauna and its equivalent faunæ in the West. It may be correlated with Dr. Merriam's 'Desert Zone or Area' in Arizona,⁴ which became later⁵ his 'Arid Lower Sonoran Zone,' and is, as a whole, the same as his 'Lower Sonoran.'

It thus appears that extra-tropical North America may be separated into about six transcontinental belts or zones, for the purpose of conveniently correlating the numerous faunæ of the continent, as follows :

- (1) An Arctic or Hyperborean Zone, coëxtensive with the American portion of the Arctic Realm.
- (2) A Subarctic, Hudsonian or 'Spruce' Zone.
- (3) A Cold Temperate, Canadian, or 'Douglass Fir' Zone.
- (4) A Temperate or Alleghanian Zone.
- (5) A Warm Temperate or Carolinian Zone.
- (6) A Subtropical or Louisianian Zone.

TROPICAL NORTH AMERICA.

It has long been recognized that the extreme southern portion of the Peninsula of Florida, the lower portion of the Rio Grande Valley, and a narrow belt extending thence northward for a

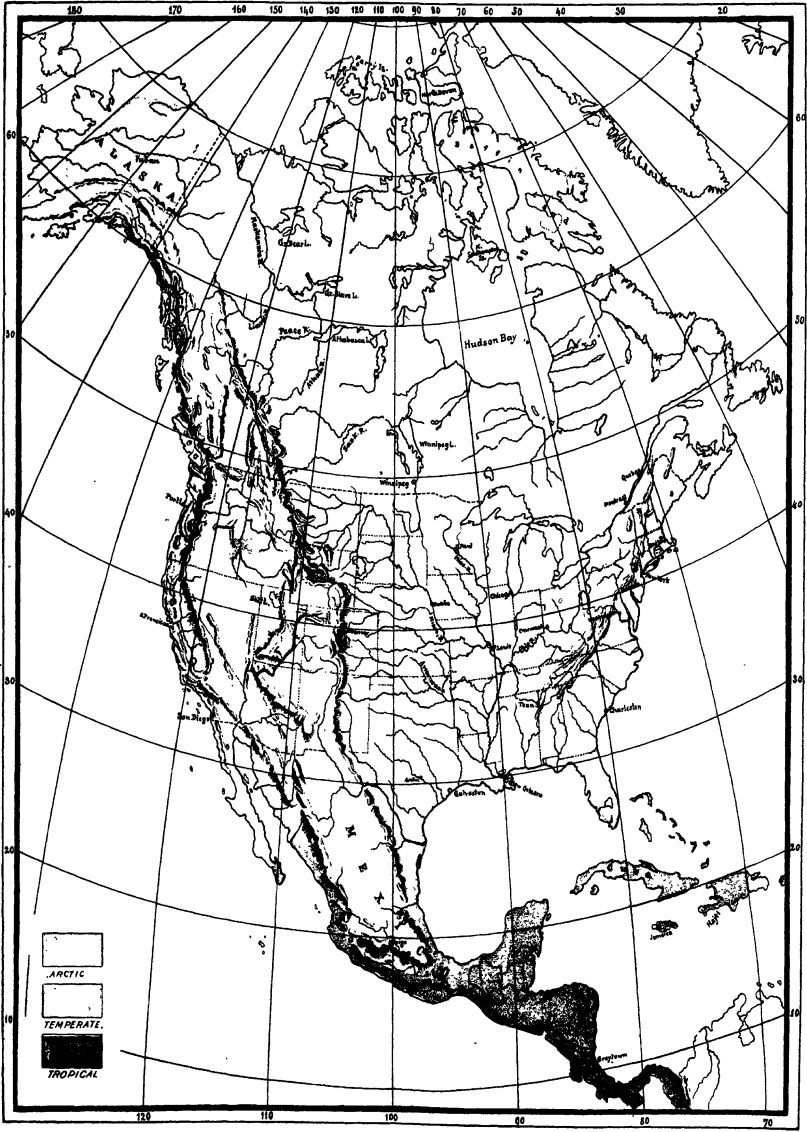
¹ In biology 'aberrant,' 'transition' or intermediate genera are frequently met with, and in some cases it is difficult to refer them to one of the two subfamilies to which they are allied rather than to the other. Yet we feel compelled to refer them to one or the other, or else to make a new subfamily for the aberrant genus, in case it shows sufficient differentiation, rather than to leave it as an isolated genus, with the rank of a genus, to be interposed between two subfamilies, or families, as the case may be.

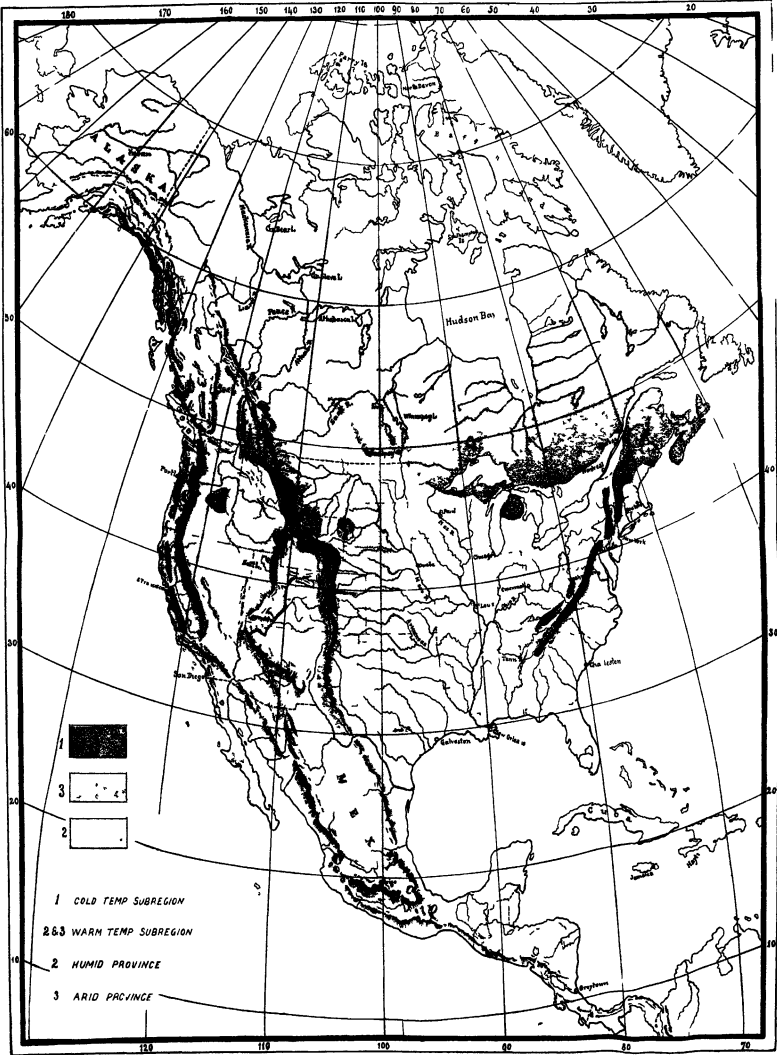
² N. Am. Fauna, No. 3, pp. 12 and 20.

³ *Ibid.*, No. 5, p. 25, and Proc. Biol. Soc. Washington, VII, p. 27.

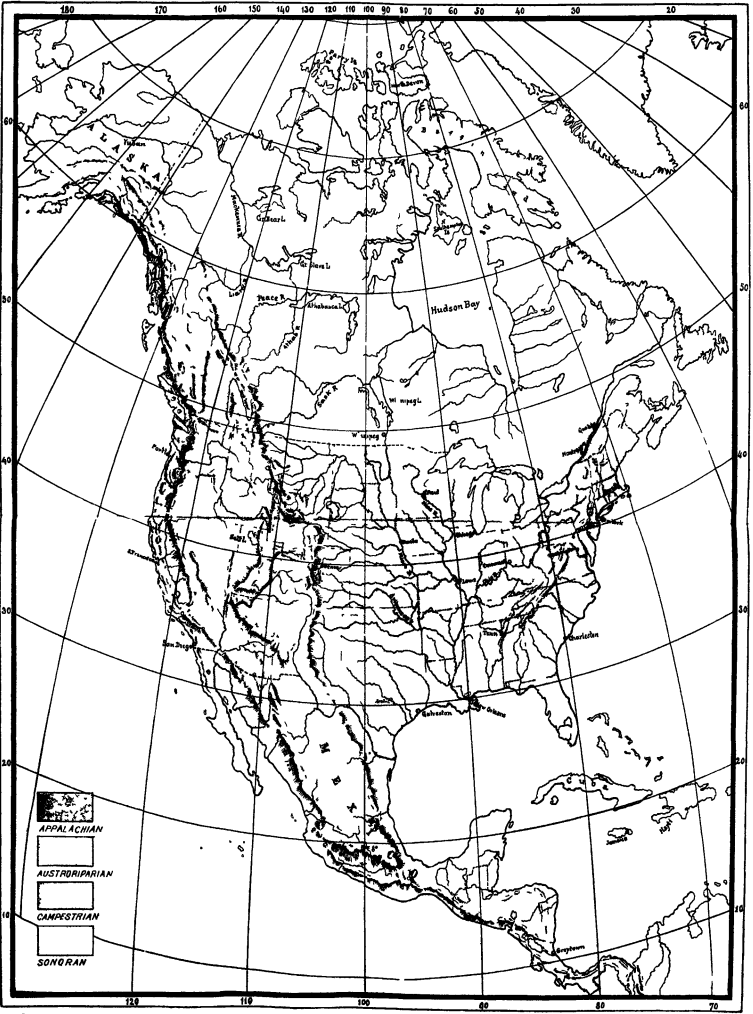
⁴ *Ibid.*, No. 3, pp. 13 and 20.

⁵ Proc. Biol. Soc. Washington, VII, p. 28.



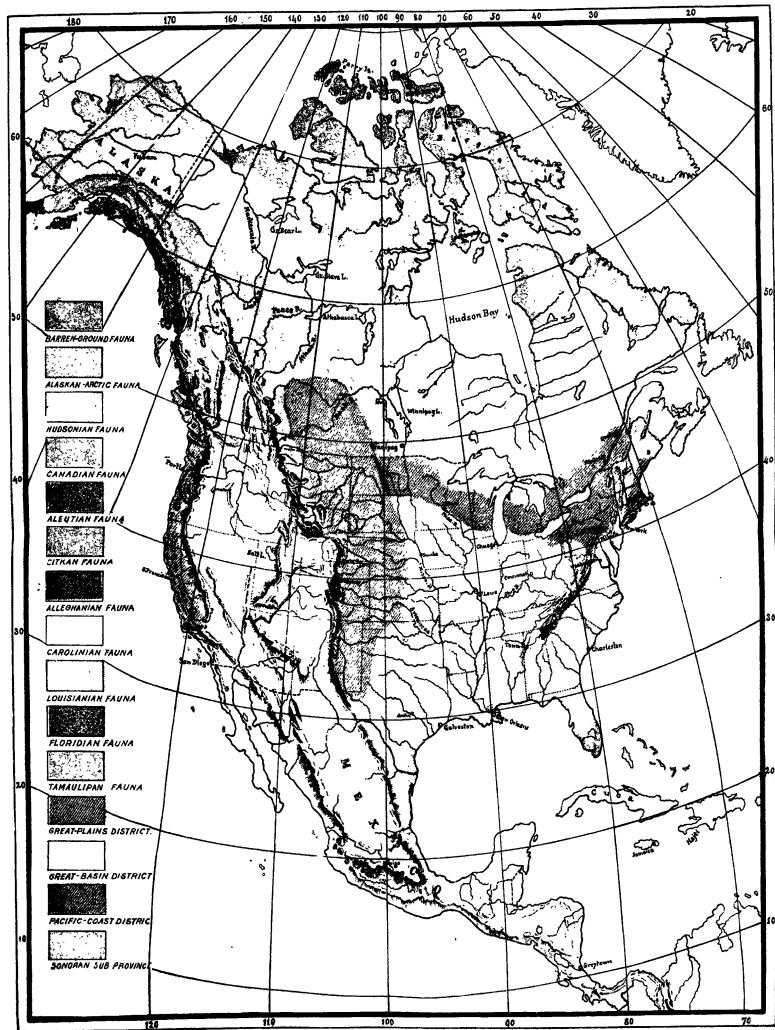


NORTH AMERICAN REGION



N. E. & P. G. Co.

SUBPROVINCES



N Y Ent & Ptg Co

DISTRICTS AND FAUNAS.

short distance along the Texas coast contain such a strong infusion of tropical types as to render these limited areas properly referable to the Tropical Realm, to which belong also all of the lowland of Mexico, including a narrow coast belt extending from the Rio Grande southward on the eastern coast and from Mazatlan southward on the western coast.

The fauna of neither of the tropical areas within the United States is typically tropical, but the infusion of tropical elements is so great as to render them tropical rather than temperate. They have also little in common with each other, as would be naturally anticipated from their wide geographical separation through the interposition of the Gulf of Mexico, thus preventing a tropical land connection. Consequently the Floridian area, or the *Floridian Fauna*, as it has long been technically known,¹ belongs to the Antillean Region of the American Tropical, while the Texan area is an outlying arm of the Central American Region of the American Tropical.

Floridian Fauna.—So far as mammals are concerned the Floridian Fauna has few distinctive elements. It has, however, a peculiar subspecies of the Wood Hare, and also of the Cotton Rat, and several species of Field Mice of the genus *Sitomys*; and the Manatee is a characteristic animal of the coast lagoons and rivers. From the standpoint of birds, insects, mollusks and plants, the Floridian Fauna is strongly characterized, not less than a dozen distinctly tropical genera of birds being represented, with a much larger infusion of tropical insects and mollusks.² Among the tropical birds which occur more or less regularly may be mentioned the Man-o'-War Bird, the Flamingo, the Florida Burrowing Owl, four West Indian species of Pigeons, the Ani, the Mangrove Cuckoo, the Dusky Seaside Sparrow, the Grassquit, the Black-whiskered Vireo, the Bahaman Honey Creeper, and various peculiar subspecies of northern birds.

Tamaulipan Fauna.—This semitropical area occupies the extreme lower portion of the Rio Grande Valley, probably not extend-

¹ Cf. Bull. Mus. Comp. Zool., II, 1871, p. 391.—The general provisional northern limit here given—"near the latitude of Lake George"—proves to have been carried a little too far north, its limits as now recognized being Cape Malabar on the east coast and Tampa Bay on the west coast. (Cf. Merriam, Proc. Biol. Soc. Washington, VII, 1892, p. 33.)

² Cf. Merriam, Proc. Biol. Soc. Washington, VII, 1892, pp. 52-54.

ing much above Hidalgo, and thus limited to within about the 100-foot contour line. It extends along the coast, mainly within the same contour line, northward to about the mouth of the Nueces River, thence gradually fading out northward, a few tropical forms extending as far north as the mouth of the Colorado River, where a number of Louisianian forms gradually disappear. South of the Rio Grande it occupies the low coast region of Mexico southward nearly to Tampico. It thus includes the greater part of the State of Tamaulipas, and the southeastern part of the State of Nuevo Leon. Among mammals the following distinctively tropical forms are either limited in their northward range by the Tamaulipan Fauna, or extend but a little way beyond it :

<i>Tatusia novemcinctus</i> ,	<i>Nasua narica</i> ,
<i>Heteromys alleni</i> ,	? <i>Putorius brasiliensis frenatus</i> ,
<i>Dipodomys phillipsii</i> ,	<i>Felis eyra</i> ,
<i>Sigmodon hispidus texianus</i> ,	“ <i>yaguairandi</i> ,
<i>Oryzomys aquaticus</i> ,	“ <i>onca</i> ,
<i>Sitomys mearnsii</i> , ¹	“ <i>pardalis</i> .
<i>Atalapha intermedia</i> ,	

The last two have been reported from as far north along the Texas coast as the Brazos River, but they are tropical rather than warm temperate species. *Dicotyles tajacu* also properly belongs here, though ranging a little further to the northward than do the others.

Among tropical birds that here reach their northern limit are the following :

<i>Podiceps dominicus</i> ,	<i>Myiozetetes texensis</i> ,
<i>Ortalis vetula macalli</i> ,	<i>Xanthoura luxuosa</i> ,
<i>Engyptila albifrons</i> ,	<i>Embernagra rufivirgata</i> ,
<i>Buteo albicaudatus</i> ,	<i>Sporophila moreletii sharpei</i> ,
<i>Crotophaga sulcirostris</i> ,	<i>Euphonia elegantissima</i> ,
<i>Trogon ambiguus</i> ,	<i>Vireo flavoviridis</i> ,
<i>Nyctidromus albigollis merrilli</i> ,	<i>Compsothlypis nigrilora</i> ,
<i>Amazilia fuscicaudata</i> ,	<i>Geothlypis poliocephala palpebralis</i> ,
“ <i>cerviniventris</i> ,	<i>Basileuterus culicivorus</i> ,
<i>Pitangus derbianus</i> ,	<i>Harporhynchus longirostris sennetti</i> .

The Tamaulipan Fauna has fewer distinctively tropical types than would be expected from its low altitude and geographical position. This is doubtless due to the extreme aridity of the

¹ = *Vesperimus mearnsii* Allen, Bull. Am. Mus. Nat. Hist., III, p. 300.

country, since in the forest regions further inland under the same parallels Trogons, Motmots and Parrots occur to a much greater extent than in the arid, nearly treeless coast region.

Tabular Synopsis of the Faunal Areas of North America.

REALMS.	{ Arctic. North Temperate. American Tropical.	
REGIONS.	{ North American. < <i>North Temperate Realm.</i> Central American. } < <i>American Tropical Realm.</i> Antillean.	
SUBREGIONS.	{ Cold Temperate. Warm Temperate. }	= <i>North American Region.</i>
PROVINCES.	{ Humid. } { Arid. }	= <i>Warm Temperate Subregion.</i>
SUBPROVINCES.	{ Appalachian. Austroriparian. } { Campestrian. Sonoran. }	{ = <i>Humid Province.</i> = <i>Arid Province.</i>
DISTRICTS.	{ Great Plains. Great Basin. } { Pacific Coast. }	= <i>Campestrian Subprovince.</i>
FAUNÆ.	{ Barren Ground. Alaskan-Arctic. } { Aleutian. Hudsonian. Canadian. Sitkan. }	{ <i>Arctic.</i> <i>Cold Temperate.</i>
	{ Alleghanian. Carolinian. Louisianian. Floridian. }	{ <i>Humid Warm Temperate.</i> <i>Tropical.</i>
	{ Tamaulipan. }	

**Article XV.—CATALOGUE OF GALL-PRODUCING
INSECTS FOUND WITHIN FIFTY MILES OF NEW
YORK CITY, WITH DESCRIPTIONS OF THEIR
GALLS, AND OF SOME NEW SPECIES.**

By WILLIAM BEUTENMÜLLER.

This catalogue is based mainly upon specimens of galls in the collection of the American Museum of Natural History, which were gathered by me during 1889-92 inclusive, when collecting entomological material for the Museum and for the Jesup Collection of 'Economic Entomology.' To make the catalogue as complete as possible I have also added such species as have already been recorded, or reported to me as having been taken within the area specified. It was originally my intention to also incorporate the descriptions of the gall-flies, whenever known, but for various reasons I have omitted them from the present catalogue.

The vegetable deformations called galls are produced by insects. Generally an egg is inserted in a bud, a leaf, a root, or some other part of the plant, and the presence of this foreign body among the vegetable cells causes an abnormal growth of a definite shape. The variety of galls in respect to structure and substance is very great. Every species of gall-producing insect attacks its own particular plant and a particular part of that plant, and produces a gall of a definite and uniform structure.

The galls enumerated in this catalogue are produced by insects belonging to the following orders: (1) Hymenoptera (Cynipidæ and Tenthrenidæ); (2) Diptera (Cecidomyidæ and Trypetidæ); (3) Hemiptera (Aphidæ and Psyllidæ); (4) Arachnida (Mites). Besides these groups, which are the principal gall-producers, some few species of other insects also produce gall-like excrescences.

I am fully aware that this catalogue is incomplete, and that a considerable number of species will yet be added as soon as we have a better knowledge of the species of gall-insects found in the vicinity of New York City.

The figures accompanying this catalogue were drawn from nature by Mr. R. Weber, and are all natural size.

HYMENOPTERA.

CYNIPIDÆ.

Rhodites bicolor (Harris).

PLATE IX, FIG. 1.

Cynips bicolor HARRIS, Ins. Inj. Veget. 1841, p. 399.

Rhodites bicolor OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 43, 48.

Round, covered with numerous long prickly spines, almost as long as the diameter of the gall. In summer the gall is yellowish green, and is sometimes tinged with red. The perfect insect was briefly described by Harris (l. c.), and a detailed description was given by Osten Sacken (l. c.). Harris's types are in the collection of the Boston Society of Natural History. The species is common on the twigs of different kinds of wild roses, growing in clusters of two or more. Common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Rhodites ignota Osten Sacken.

PLATE IX, FIG. 2.

Rhodites ignota OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 43, 49.

This gall is round, about the size of a pea, and covered with a white mealy substance. Sometimes two or three of these galls coalesce, thus forming an elongated mass of more irregular shape. In texture the gall is hard and woody, and each contains several cells. I have taken it plentifully on the leaves of *Rosa carolina*, in September, at West Farms, New York City.

Two examples. Coll. Am. Mus. Nat. Hist.

Rhodites radicum Osten Sacken.

PLATE IX, FIG. 3.

Rhodites radicum OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 42, 46.

Found at the roots of various kinds of wild roses. The gall is irregularly rounded, and with a deep depression above and below at the place of attachment to the roots. It is smooth and red-

dish brown in color. The inside is composed of a pithy substance, and contains numerous cells. Taken on Staten Island by Mr. Wm. T. Davis and myself.

Six specimens. Coll. Am. Mus. Nat. Hist.

Rhodites globulus, n. sp.

PLATE IX, FIG. 4.

This is certainly the unnamed gall described by Osten Sacken (Proc. Ent. Soc. Phil., Vol. II, p. 42).

The gall is smooth, rounded and rises at each end abruptly from the branch. In substance it is rather soft and corky, with numerous cells inside. In form it is sometimes more or less oblong or is almost round, and measures from three-quarters of an inch to an inch and a half in length and is about three quarters of an inch in diameter. Found on Swamp Rose (*Rosa carolina*) on Staten Island.

GALL-FLY. *Male*.—Head jet black, not shining, rugosely punctate. Antennæ black. Thorax deeply corrugated, jet black above and below. Legs black with joints and tarsi yellowish brown. Body shining black, finely punctured. Length, 3 mm.

Female.—Differs from the male by having only the posterior pair of legs marked with black and the two other pairs wholly yellowish brown. It is also larger, with the anal valve considerably longer. Length, 5 mm.

Described from one male and one female. Types Coll. Am. Mus. Nat. Hist.

Rhodites dichlocerus (Harris).

PLATE IX, FIG. 5.

Cynips dichlocerus HARRIS, Ins. Inj. Veget. 1841, p. 399.

Rhodites dichlocerus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 41, 46.

This gall is an elongated, hard, woody swelling, gradually tapering at both ends. It occurs on the branches of *Rosa carolina*. The originator of the gall was briefly described by Harris (l. c.) and accurately characterized by Osten Sacken (l. c.). Taken at Kingsbridge, N. Y., and on Staten Island. Not common. I have examined the type specimen of the gall in the Museum of the Boston Society of Natural History.

Several examples. Coll. Am. Mus. Nat. Hist.

Rhodites verna *Osten Sacken.*

PLATE IX, FIG. 6.

Rhodites verna OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 41, 47.

Taken by me on Staten Island on the Wild Rose (*Rosa lucida*). The gall is somewhat allied to *Rhodites dichlocerus* Harr. It is oblong or rounded, and about one-third of an inch long. Sometimes there is a series of three or four such swellings attached to each other, and in this respect differs from *R. dichlocerus*. The figure here given was drawn from an authentic specimen in the Museum collection.

Rhodites rosæ (*Linn.*).*Cynips rosæ* LINN. Syst. Nat. 10th Edit. Vol. I, p. 533.*Rhodites rosæ* OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, p. 47; HARRIG, Zeitschr. f. d. Ent. II, 1840, p. 194.

This gall, according to Osten Sacken, is identical with the European species, where it is well known under the name of 'Bedeguar,' said to mean rose apple. In this country it occurs on the Sweet Briar (*Rosa carolina*). It is composed of an agglomeration of hard cells around a branch, and is wholly covered with long and dense green filaments, forming a moss-like mass an inch and a half or more in diameter. I have taken a gall of a similar nature on the leaves and stems of the common Blackberry (*Rubus villosus*) and which probably is identical with *Rhodites rosæ* Linn. Not common.

One example. Coll. Am. Mus. Nat. Hist.

Diastrophus bassettii, n. sp.

PLATE IX, FIG. 7.

The gall of this species was found by Mr. W. T. Davis on Staten Island, on the stems of the Trailing Blackberry (*Rubus canadensis* ?). It is irregularly rounded or somewhat elongated, and grows near the ground, but not beneath the surface as does *D. radicum* Bass. In color it is greenish, and is tinged with red. Inside there are numerous rounded cells in the pithy substance of which the gall consists. Mr. H. F. Bassett informs me that he also found this gall many years ago on the stems of the 'Trailing Blackberry,' but did not secure the gall-flies and therefore

did not describe it. The gall is very different from that of *D. radicum* Bass., under which name it has been known to me for some time past, but comparing it with type specimens of *D. radicum*, kindly sent me by Mr. Bassett, I find it totally different. In cutting open one of the galls I found two mature flies and several partly-developed specimens.

The flies may be described as follows :

Head jet black, very shining, with a number of shallow punctures, in each of which is a very short yellowish hair. Mouth parts pitchy brown. Thorax shining, smooth, jet black, with two deep longitudinal grooves; scutellum less shining and deeply corrugated, as are also the sides and extreme anterior portion of the thorax. Antennæ testaceous, thirteen-jointed; first joint elongated, much thicker at the extreme end than at the base; second joint almost globular and about one-half as long as the first; third joint slender, longer than the first, becoming slightly thicker toward the apex; fourth to sixth joints about the same size and shorter than the third; the remaining joints are still somewhat smaller, but are about the same size; last joint, bud-shaped. The antennæ are also sparsely covered with short yellowish hair. Body jet black, shining. Legs, testaceous. Two males. Length, 4 mm.

Types of gall and flies in Coll. Am. Mus. Nat. Hist.

***Diastrophus cuscuteformis* Osten Sacken.**

PLATE X, FIG. 1.

Diastrophus cuscuteformis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, pp. 39, 45.

This gall infests the branches of the common Blackberry (*Rubus villosus*), and consists of globular, woody, seed-like bodies. They are pressed closely together, and each is provided with more or less spines. Not common.

Two specimens. Coll. Am. Mus. Nat. Hist.

***Diastrophus nebulosus* Osten Sacken.**

PLATE X, FIG. 2.

Diastrophus nebulosus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. II, p. 36; RILEY, Am. Ent. Vol. II, p. 159; FULLER, Am. Ent. Vol. III, p. 63; SAUNDERS, Ins. Inj. Fruit, p. 318.

This large swelling is found on the canes of the Blackberry (*Rubus villosus*). It is about two or three inches long, and when immature is dark green, turning red or reddish brown as the season advances. It is oblong in form, with the surface some-

what uneven, with deep longitudinal furrows, which divide the gall more or less completely into four or five parts. Inside there are numerous oblong cells, each containing a single larva, which is about one-tenth of an inch long, white, with the mouth parts and the spiracles and an oval spot on each side behind the head of the same color. The perfect insect emerges in spring the following year. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

***Diastrophus potentillæ* Bassett.**

Diastrophus potentillæ BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 689.

Found on the axils of the leaves of *Potentilla canadensis*. In summer the gall is green, and when dry is of a spongy substance. Each gall contains a single cell. It is round or oblong in shape and measures about one-third of an inch in diameter. Not common. Taken at Fort Lee, N. J., Astoria, L. I., and Staten Island.

***Amphibolips confluentus* (Harris).**

PLATE X, FIG. 4.

Cynips confluentus HARRIS, Rep. Ins. Inj. Veget. 1st Ed. 1841, p. 397.

Cynips confluentus HARRIS, Rep. Ins. Inj. Veget. 2d Ed. 1852, p. 433; *ibid.* 3d Ed. 1862, p. 546; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 53; WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.

Cynips aciculata OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 56, 245; *ibid.* Vol. IV, p. 354; WALSH, Proc. Ent. Soc. Phil. Vol. II, pp. 443, 462, 481; Am. Ent. Vol. II, p. 330; WALSH & RILEY, Am. Ent. Vol. I, p. 103.

Cynips coccineæ OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, pp. 243, 248; *ibid.* Vol. IV, p. 354; WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.

Amphibolips coccineæ ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 104.

Cynips spongifica OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, pp. 244, 248; *ibid.* Vol. IV, p. 347; WALSH, Proc. Ent. Soc. Phil. Vol. II, pp. 443, 452; Am. Ent. Vol. II, p. 330; WALSH & RILEY, Am. Ent. Vol. I, p. 103.

Amphibolips spongifica ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 104.

This well-known gall is very common in this vicinity, and makes its appearance early in May, as soon as the leaves put forth, on different kinds of oaks, belonging to the red oak group, and is fully grown in a few weeks. It is popularly known as 'Oak-apple' or 'May-apple,' owing to its resemblance to a small apple. The gall measures from one to two inches in diameter, and is more or less smooth and globular, sometimes slightly

elongated. Inside it is filled with a spongy substance in the centre of which is a hard kernel containing the larval cell. When fresh the gall is a pale green, soft and succulent, with the contents whitish. But later in the season the shell becomes brown, hard and brittle, with the kernel woody and the spongy substance dark brown, but remaining soft.

From a certain number of these galls emerge, by the middle of June, both male and female gall-flies. These have been named by Osten Sacken, *Cynips (Amphibolips) spongifica*. The gall-flies which emerge in October or the following spring are all females, and have been named *Cynips (Amphibolips) aciculata* by the same author, but they have been proven by the late B. D. Walsh to be merely a dimorphous female of the former. *A. aciculata* and *A. spongifica* were supposed by Osten Sacken to be two different species and to occur on the Black Oak (*Quercus tinctoria*) only. I have, however, bred specimens of the autumnal form (*A. aciculata*) from galls which I found on Red Oak (*Quercus rubra*), Scarlet Oak (*Quercus coccinea*), Black Oak (*Quercus tinctoria*) and Black-jack Oak (*Quercus nigra*), which I am unable to separate from an authentic specimen of *A. aciculata* deposited in the Museum by Baron Osten Sacken some years ago. I have also examined Harris's type of *C. confluentus* in the collection of the Boston Society of Natural History, and find it to be identical with *A. aciculata* O. S., over which the name *A. confluentus* has precedence.

A. coccinea O. S. was described from the gall only, and Walsh (Proc. Ent. Soc. Phil., Vol. II, p. 447), was certainly correct in uniting it with *A. spongifica*.

Amphibolips inanis (Osten Sacken).

PLATE X, FIG. 5.

Callaspida confluentus FITCH, 5th Rep. Nox. Ins. in Trans. N. Y. State Agricul. Soc. 1858, p. 817.

Cynips inanis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 58, 242, and Vol. IV, p. 354; WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 457; Am. Ent. Vol. II, p. 331; WALSH & RILEY, Am. Ent. Vol. I, p. 105.

Amphibolips inanis ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 104.

The outside of this gall shows no difference from that of the preceding species, except in being considerably smaller. The

internal structure, on the contrary, distinguishes it at once. Instead of being filled with the spongy substance, as in *A. confluentus* Harr., this gall is almost empty; the larval cell being kept in its central position by a certain number of whitish filaments which radiate from it to the shell. Found in May on the leaves of the Scarlet Oak (*Quercus coccinea*) and Red Oak (*Quercus rubra*). Not common. West Farms, N. Y., Fort Lee, N. J., and Staten Island.

Two examples. Coll. Am. Mus. Nat. Hist.

***Amphibolips ilicifoliae* (Bassett).**

PLATE X, FIG. 6.

Cynips ilicifoliae BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 681.

Amphibolips ilicifoliae ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294;
PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Occurs on the leaf or petiole of *Quercus ilicifolia*. It is elongated and fusiform, tapering at both ends, with the apex somewhat longer and more slender than the basal portion, and is sometimes considerably curved. The gall is green or brownish, thin and brittle when dry, with an elongated kernel inside, held in position by radiating fibres. Rare in the vicinity of New York. Taken by W. T. Davis at Tottenville, S. I., and by the late Hy. Edwards at Vineland, N. J.

Three examples. Coll. Am. Mus. Nat. Hist.

***Amphibolips prunus* (Walsh).**

Cynips prunus WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 639; WALSH & RILEY, Am. Ent., Vol. I, p. 104.

Amphibolips prunus ASHMEAD; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

In the latter part of August and early in September this gall may be found fully developed, and growing from one side of the acorn of the Red Oak (*Quercus rubra*) and Black Oak (*Quercus tinctoria*). It is globular, smooth, and fleshy, but is solid, and somewhat resembles a plum. Outside it is of a bright crimson and internally it is pinkish shading into yellow towards the middle. The larva lives singly in a cell in the centre of the gall, and the perfect insect emerges in May the following year. According to Walsh (Am. Ent., I, p. 104) it sometimes remains in

the larva state for two years and does not eat its way out until the end of the third year. The gall measures from a half to one inch in diameter. Not rare in this vicinity. I have taken it in abundance at Fort Lee, N. J.

Andricus (Callirhytis) cornigerus (Osten Sacken).

PLATE X, FIG. 3.

Cynips cornigera OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 251, and Vol. IV, p. 358.

Andricus (Callirhytis) cornigera BASSETT, Am. Nat. Vol. XVI, p. 246.

Andricus (Callirhytis) cornigerus ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This is one of the most common galls found in the vicinity of New York City. It infests the branches of the Pin Oak (*Quercus palustris*) and is often found by the hundreds upon a single tree. The gall is irregularly rounded and is composed of a woody substance, with numerous horn-like protuberances, through which the gall-flies make their escape. Internally there are numerous cells, each containing a single larva. The perfect insect emerges from the gall early in spring. The gall also occurs on the Scrub Oak (*Quercus ilicifolia*) and Black-jack Oak (*Quercus nigra*), but very rarely.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) punctatus (Bassett).

Cynips punctata BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 324; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 358.

Andricus (Callirhytis) punctata BASSETT, Am. Nat. Vol. XVI, p. 246.

Andricus (Callirhytis) punctatus ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Closely allied to *Andricus cornigerus* O. S., but may be readily separated from this species by the absence of the horn-like protuberances. It is one of the most conspicuous galls, and by its abundance, wherever it occurs, it deforms the trees and does considerable injury. Sometimes the gall is found singly, but often a number of them may be seen, in more or less proximity, on the same twig. It is composed of a woody substance and internally there are a number of cells, as in *A. cornigerus* O. S. I have taken the gall in abundance at Cold Spring Harbor, L. I., on

the Black-jack Oak (*Q. nigra* L.). It is also found on the Scarlet Oak (*Q. coccinea*), Red Oak (*Q. rubra*), and Scrub Oak (*Quercus ilicifolia*).

Two examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) seminator (Harris).

Cynips seminator HARRIS, Rep. Ins. Inj. Veget. 1st Edit. p. 399; FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 813; WALSH & RILEY, Am. Ent. Vol. I, p. 250, and Vol. II, p. 71.

Andricus seminator OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.

Andricus (Callirhytis) seminator BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall is found in June growing on small twigs of the White Oak (*Quercus alba*). It is composed of a woolly substance, and is irregularly rounded. Inside are numerous seed-like bodies adhering around the twig, and very much resembling canary seeds. The gall is pure white or white tinged with red, but towards the middle of the summer assumes a rusty brown shade. It measures from one inch to about two inches and a half in diameter. Common.

Two examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) futilis (Osten Sacken).

PLATE XI, FIG. I.

Cynips futilis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 63.

Andricus futilis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.

Andricus (Callirhytis) futilis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall is a pale green, rounded, somewhat flattened, and projects on both sides of the leaf. Inside there are two or three seed-like, oblong kernels, kept in position by some whitish filaments. It appears early in May on the leaves of the White Oak (*Quercus alba*) and is fully grown about the middle of the month or early in June. The perfect insect emerges in the latter part of June or early in July, when the gall becomes dry and changes to a light brown color. Very common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) papillatus (Osten Sacken).

Cynips papillata OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 64, and Vol. IV, p. 352.

Andricus papillata OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.

Andricus (Callirhytis) papillatus ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Occurs in numbers on the same leaf on the Chestnut Oak (*Quercus prinus*). The gall is rounded and projects on both sides of the leaf; it is somewhat nipple-shaped, and is enclosed in a reddish aureola on the under side, which is very characteristic and by means of which it can be separated from the preceding species. Inside the gall are two or three kernels each containing a single larva. It is found in May and the perfect insect emerges in June. Probably this and the preceding species are the same, attacking two kinds of oaks. Not common.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) similis (Bassett).

PLATE XI, FIG. 2.

Cynips similis BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 685.

Andricus (Callirhytis) similis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

In general appearance this gall very much resembles that of *C. tuber* Fitch, as does also the perfect insect, but, according to Mr. Bassett, it is evidently a different species. The gall is club-shaped and woody, growing at the ends of small limbs. The apex is blunt and generally turned to one side, covered in summer with a few leaves. The gall is rare in this vicinity and is found on *Quercus ilicifolia*. It has been taken by W. T. Davis at Tottenville, S. I., and by myself at Tom's River, N. J.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) clavula (Bassett).

PLATE XI, FIG. 3.

Cynips arbor FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 809; BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 686.

Cynips clavula BASSETT, Proc. Ent. Soc. Vol. IV, p. 351; OSTEN SACKEN, Proc. Ent. Soc. Vol. IV, p. 379.

Andricus (Callirhytis) clavula BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

Forms a club-shaped gall at the tips of the twigs of the White Oak (*Quercus alba*). Early in summer it is green; in winter it is of the same color as the twig, and is very hard and woody. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Andricus (Callirhytis) palustris (Osten Sacken).

Cynips palustris OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 62, and Vol. III, p. 359; Trans. Am. Ent. Soc. Vol. III, p. 54.
Andricus (Callirhytis) palustris BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 294; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

The shell of this gall is green and succulent. Inside it is hollow, with a small whitish globular body of about one-tenth of an inch in diameter, containing the larva, and rolls freely about, not being fastened to the shell. The gall is globular, measures about one-half inch in diameter, and occurs on the buds and young leaves of the Pin Oak (*Quercus palustris*) early in May. The perfect insect emerges about the middle of May. Very common in Central Park and at Astoria, L. I.

Andricus singularis (Bassett).

PLATE XI, FIG. 4.

Cynips singularis BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 326; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 355.
Andricus singularis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall may be found in the early part of June, infesting the leaves of the Red Oak (*Q. rubra*). It is smooth, thin, and varies in diameter from a quarter to one-half an inch. Each gall has an oblong cell in the centre, which is held in place by radiating fibres. There is seldom more than one gall on each leaf, although two and even three are occasionally met with. The gall reaches its full development with the leaf, and the perfect insect emerges in July. At first the gall is green and succulent, but turns brown and becomes brittle later in the season. In general appearance this gall resembles *Amphibolips inanis* O. S., but may be readily distinguished by its small size.

Several examples. Coll. Am. Mus. Nat. Hist.

Andricus petiolicola (Bassett).

PLATE XIII, FIG. 2.

Cynips petiolicola BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 325.*Andricus petiolicola* OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379 ; BASSETT, Am. Nat. Vol. XVI, p. 246 ; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295 ; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

This gall affects the petiole at the base of the leaf and sometimes also the mid-rib. It is found on the White Oak (*Quercus alba*), Chestnut Oak (*Quercus prinus*), Swamp White Oak (*Quercus bicolor*) and Post Oak (*Quercus obtusiloba*). It is rounded or club-shaped, and is of a woody texture ; contains a number of cells. Early in the season it is green, but later becomes brown. Common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

Andricus lana (Fitch).

PLATE XI, FIG. 5.

Cynips lana FITCH, 5th Rep. Nox. Ins. Trans. N. Y. State Agricul. Soc. 1858, p. 814.*Andricus lana* ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295 ; PACKARD, 5th Rep. U. S. Ent. Com. p. 105.

The oak-wool gall is found upon the principal veins on the undersides of the leaves of the White Oak (*Quercus alba*). It very much resembles a small mass of wool, and is white or buff colored. Internally this mass is composed of numerous small seed-like capsules of a bright chestnut color, crowded together and attached by their lower ends to the vein of the leaf. Common.

Coll. Am. Mus. Nat. Hist.

Cynips (?) prinoides, n. sp.

PLATE XI, FIG. 6.

A number of galls of this species were collected by me at Tom's River, New Jersey, from the upper sides of the leaves of the Dwarf Chestnut Oak (*Quercus prinoides*) in the latter part of August and early in September. The gall is globular and about one-half inch in diameter, and is covered with numerous cone-like projections. When fresh it is light green tinged with red. [December, 1892.]

Inside is a single cell in which the larva lives. I did not succeed in raising any flies from the galls, but have found in cutting open one of them an apparently mature female specimen, which I describe as follows :

Sub-apterous; head, pitchy black, opaque, rugosely punctured; eyes also pitchy black, finely reticulated, and surrounded with a rather broad reddish brown ring. Antennæ black, thirteen jointed, with the first four joints elongated and about the same length; the remaining joints gradually decrease in size. Thorax dull reddish brown, darker in color at the sides, and deeply but finely punctate. Legs shining, reddish brown, with a few short yellowish hairs, which are also present on the head and thorax. Body jet black, very shiny; ovipositor with a few light-colored hairs. On the underside of the body, a little beyond the middle and in close proximity, are two bunches of rather long yellowish hairs. A few very short hairs of the same color are also present on the underside of the body at the base. Length, 3.5 mm.

I place the species only provisionally in the genus *Cynips*.

***Cynips strobilana* Osten Sacken.**

PLATE XII, FIG. 6.

Cynips strobilana OSTEN SACKEN, Proc. Ent. Soc. Phil. I, p. 254; BASSETT, Proc. Ent. Soc. Phil. III, p. 690; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295.

This gall consists of a number of wedge-shaped bodies, closely packed together, with their pointed bases attached to a common centre. These wedges are hard and corky, and break off very easily when the gall is dry. Each of them contains a hollow kernel with a plump larva inside. According to Osten Sacken this gall is evidently produced by the sting of the insect on the single leaves of a bud, each leaf growing into the shape of a wedge. It occurs on the tip of the twigs of the Swamp Oak (*Q. bicolor*), and is rare in this neighborhood.

One specimen. Coll. Am. Mus. Nat. Hist.

***Cynips pisum* Fitch.**

Cynips pisum FITCH, 5th Rep. Nox. Ins. N. Y. Trans. N. Y. Agri. Soc. XVIII, p. 818; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 59; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 303.

Common on the veins of the upper or underside of the leaves of the White Oak (*Q. alba*). The gall is about the size of a pea,

which it very much resembles in general appearance. Its surface is finely nettled with fissures or cracks and intervening elevated points, like the surface of a strawberry. Inside there are usually two cavities divided in the centre by a thin partition. The gall is pale greenish yellow tinged on one side with red. It may be found fully developed in June and July.

Several examples. Coll. Am. Mus. Nat. Hist.

***Acraspis erinacei* (Walsh).**

PLATE XII, FIG. 1.

Cynips erinacei WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 483.

Acraspis erinacei MAYR, Genera der Gallbew. Cynipid. p. 29; BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 295; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall appears in June and July on the leaves of the White Oak (*Quercus alba*), and is fully developed in August and September. It is attached by a single point to the leaf, and generally grows on one of the principal veins on the upperside. When fully grown the gall is rounded and is finely nettled with fissures and covered with rather long spines. It is yellow or greenish yellow with the spines bright red, especially so when young.

Six specimens. Coll. Am. Mus. Nat. Hist.

***Biorhiza forticornis* (Walsh).**

PLATE XIII, FIG. 3.

Cynips ficus FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 812; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 368.

Cynips (Biorhiza) forticornis WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 490.

Teras forticornis OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.

Acraspis forticornis BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

These galls occur in a dense cluster around the young twigs or tender shoots of the White Oak, and each is moulded to the shape of those pressing against its sides, and somewhat resembles preserved figs packed in boxes, hence the name 'Fig-gall.' The gall is soft, bladder-like, and inside contains a single cell, held in place by radiating fibres. It is pale yellow, often beautifully tinged with bright red. In winter the gall is of the color of a faded

oak leaf. It is fully grown in August. The gall and guest-fly have been named by Fitch *Cynips ficus*. But the true gall-maker was discovered later by Walsh who named the species *Biorhiza forticornis*.

Several examples. Coll. Am. Mus. Nat. Hist.

***Biorhiza hirta* (Bassett).**

Cynips hirta BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 688; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 353.

Teras hirta OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. IV, p. 379.

Biorhiza hirta ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall measures about one-quarter of an inch in diameter. It is hard, round, with a fine papillose surface and a solid radiating cellular structure. It usually grows on the underside of the leaf attached to one of the larger veins by a very short pedicel, but is also sometimes found on the upperside. It is very rare in this vicinity and is found on Rock Chestnut Oak (*Q. monticola*). A single specimen, so named, is in the Museum collection from West Point, N. Y., collected by Baron Osten Sacken.

***Holcaspis globulus* (Fitch).**

PLATE XII, FIG. 4.

Callaspidia globulus FITCH, 5th Rep. Nox. Ins. N. Y. State Agricul. Soc. 1858, p. 811; PACKARD, 5th Rep. U. S. Ent. Com. p. 111.

Cynips globulus OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 67; BASSETT, Proc. Ent. Soc. Phil. Vol. II, p. 328.

Holcaspis globulus MAYR, Genera der Gallbew. Cynipid. p. 35; BASSETT, Am. Nat. Vol. XVI, p. 246; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

These bullet-like galls are common on the White Oak (*Quercus alba*), and grow singly or in clusters of two, three or more on the terminal twigs. Internally the gall is of a corky texture and contains in its centre a single worm, lying in an oval, whitish shell, resembling a minute egg. In summer the gall is yellow or tinged with red, and when the colder weather sets in it turns brown. The gall is also found on the Post Oak (*Quercus obtusiloba*) and Chestnut Oak (*Quercus prinus*).

Several examples. Coll. Am. Mus. Nat. Hist.

Holcaspis duricoria *Bassett.*

PLATE XII, FIG. 5.

Holcaspis duricoria BASSETT, Trans. Am. Ent. Soc. Vol. XVII, p. 64; Am. Nat. Vol. XVI, p. 246.

Somewhat resembles the gall of *H. globulus* Fitch, but may be readily distinguished by being much rougher outside and less regularly globular, with the base flattened and the apex extended into a cone-like process. Internally the substance is similar, but much harder than that of *H. globulus*. It also contains a free larval cell. Occurs on the Swamp Oak (*Q. bicolor*). Rare in the vicinity of New York.

A few specimens. Coll. Am. Mus. Nat. Hist.

Dryophanta polita (*Bassett*).

PLATE XII, FIG. 3.

Cynips polita BASSETT, Can. Ent. Vol. XIII, p. 99.

Dryophanta polita BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 106.

This gall is globular, and is found in August and September on both surfaces of the leaves of the Post Oak (*Quercus obtusiloba*) at or near the summit of young and thrifty shoots, from one to twenty occurring on a single leaf. It is one-quarter to three-quarters of an inch in diameter, and pale green, but when exposed to the sun becomes red or reddish brown. When dry the shell is very thin and brittle, and contains a single round larval cell, held in a central position by radiating branching fibres which extend to the outer shell. The perfect insect, according to Mr. Bassett, becomes mature in October but remains in the gall over winter.

Common at Tom's River, New Jersey. Taken by Mr. W. T. Davis and myself.

One fine example. Coll. Am. Mus. Nat. Hist.

Neuroterus batatus (Fitch).

PLATE XIII, FIG. 1.

Cynips batatus FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 810; OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. I, p. 71; BASSETT, Proc. Ent. Soc. Phil. Vol. III, p. 684.

Neuroterus batatus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Abundant, especially on the branches of young trees. The gall is generally large and uneven, and often resembles a potato in shape. It is hard and woody, with the surface coated with a glaucous, pale bluish bloom. Internally it is of a dense corky texture with numerous larval cells. The gall grows on the White Oak below the terminal shoot, and is sometimes quite injurious by deforming the young twigs of the tree.

Numerous examples. Coll. Am. Mus. Nat. Hist.

Neuroterus noxiosus (Bassett).

Cynips noxiosa BASSETT, Can. Ent. Vol. XIII, p. 108.

Neuroterus noxiosus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Found on the terminal twigs of the Swamp White Oak (*Quercus bicolor*). It very much resembles that of *Neuroterus batatus* in shape and size. But according to Mr. Bassett the flies that produce this gall are distinct. Taken by me in Central Park. Rare. Two type specimens of the summer form and three of the winter form were given to the Museum by Mr. H. F. Bassett.

Neuroterus floccosus (Bassett).

PLATE XII, FIG. 2.

Cynips floccosa BASSETT, Can. Ent. Vol. XIII, p. 111.

Neuroterus floccosus BASSETT, Am. Nat. Vol. XVI, p. 246; ASHMEAD, Trans. Am. Ent. Soc. Vol. XII, p. 296; PACKARD, 5th Rep. U. S. Ent. Com. p. 107.

Very common on the under surface of the terminal leaves of the Swamp Oak (*Quercus bicolor*). Sometimes as many as two hundred galls are often found upon a single leaf, and which cause the leaf to become deformed and to curl up. The gall is hemi-

spherical and covered with white hairs. On the upperside of the leaf its position is indicated by a small, smooth, shining blister-like elevation. I have found the gall fully grown in July, and others in various stages of growth, as well as the perfect insect ovipositing.

Numerous examples. Coll. Am. Mus. Nat. Hist.

***Neuroterus umbilicatus* Bassett, MS.**

Occurs in considerable numbers on the underside of the leaves of the Swamp White Oak (*Quercus bicolor*). The gall is rounded, much depressed, with a deep circular cavity on top, in the centre of which is a small nipple. It is brown, and measures about one-tenth of an inch in diameter. Its position is indicated on the upper surface of the leaf by a circular spot. Taken by me on Staten Island. Not rare.

Three type specimens were kindly presented to the Museum by Mr. H. F. Bassett.

***Aulax tumidus* Bassett.**

Aulax tumidus BASSETT, Trans. Am. Ent. Soc. Vol. XVII, p. 92.

This gall forms a thick swelling on the main stalk of Wild Lettuce (*Lactuca*). It is usually found near the summit of the stalk, often in the panicle itself and then covered with the short flower stems. The gall varies greatly in size from a slight, knotty and irregular enlargement of the stalk to a large and more or less ovate swelling, two or three inches long and an inch in diameter. The larvæ are imbedded in the soft pitchy matter which fills the gall.

Two specimens. Coll. Am. Mus. Nat. Hist.

TENTHRENIDÆ.

***Nematus pomum* Walsh.**

Nematus pomum WALSH, Proc. Ent. Soc. Phil. Vol. VI, p. 255; WALSH & RILEY, Am. Ent. Vol. II, p. 45 (fig.).

Found on several species of bush Willows (*Salix*). It makes its appearance early in spring and is fully matured in July and August. The gall is yellowish green, usually with a rosy cheek,

and measures about one-half inch in diameter. It is rounded and somewhat resembles a miniature apple. Common.

***Euura ovum* Walsh.**

Euura ovum WALSH, Proc. Ent. Soc. Phil. Vol. VI, p. 251; WALSH & RILEY, Am. Ent. Vol. II, p. 49 (fig.).

This gall is found on the stems of the Willow (*Salix*), and is an oval or elongated swelling, about one-half an inch long, placed lengthwise on one side of the twig. Not common.

DIPTERA.

CECIDOMYIDÆ.

***Cecidomyia serrulata* Osten Sacken.**

PLATE XIII, FIG. 4.

Cecidomyia serrulata OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 198.

The gall is a deformation of the terminal bud of the common Alder (*Alnus serrulata*), which appears enlarged and rounded, with the apex pointed. In autumn it is greenish; in winter, brown, and often covered with a whitish efflorescence. Each gall contains from two to six reddish larvæ, which leave the gall late in fall to complete their transformation in the earth. The fly emerges the following spring. Common at Ravenwood, Long Island, and Mosholu, N. Y.

Six specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia verrucicola* Osten Sacken.**

Cecidomyia verrucicola OSTEN SACKEN, Can. Ent. Vol. VII, p. 200.

This gall is found in July and August on the leaves of the Linden (*Tilia americana*). It occurs in numbers upon the same leaf, and is wart-shaped, round, pale green, and measures about one-fifth of an inch in diameter. In autumn the gall becomes brown, hard and woody, and springs open on the underside, a circular piece detaching itself and either falling to the ground or remaining fastened to the gall at one edge, in the shape of a lid.

Taken by me near Yonkers, N. Y., and by Baron Osten Sacken, near West Point, N. Y.

***Cecidomyia tulipiferæ* Osten Sacken.**

Cecidomyia tulipifera OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202.

Taken by me at Short Hills, New Jersey, on the Tulip-tree (*Liriodendron tulipifera*). The gall infests the mid-rib of the leaf, and is a small rounded swelling. Rare.

***Cecidomyia liriodendri* Osten Sacken.**

Cecidomyia liriodendri OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202.

Forms brown spots with a yellow or greenish aureole on the leaves of the Tulip-tree. These spots are about one-third of an inch in diameter, and a number of them may be found upon a single leaf. Common.

Several specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia cerasi-serotinæ* Osten Sacken.**

Cecidomyia cerasi-serotina OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, p. 346.

The gall is an enlargement of the terminal bud of young shoots of the Wild Cherry (*Prunus serotina*), and makes its appearance in May. It is bright red, more or less rounded, with one or two leaves growing from its sides. The consistency of the gall when young is fleshy; the cavity on the inside occupies about one-half of the diameter of the gall and is filled with bright yellow larvæ, which, according to Osten Sacken (l. c., p. 347) have the power of leaping by the contraction of their bodies. Found in Tarrytown, N. Y., by Osten Sacken. I have also taken it in Central Park, New York City. Rare.

***Cecidomyia pellex* Osten Sacken.**

Cecidomyia pellex OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199.

Taken at Fort Lee, New Jersey, in June, on the Ash (*Fraxinus americana*). The gall occurs on the ribs of the leaf, is rounded oblong on the upperside, and on the underside it is indicated by the surface being somewhat swollen. It is pale green, succulent, subpellucid, and sometimes is tinged with brown.

***Cecidomyia gleditschiæ* Osten Sacken.**

Cecidomyia gleditschia OSTEN SACKEN, Proc. Ent. Soc. Phil. Vol. VI, p. 219.

Taken in Central Park, New York City, in June and July, on the leaves of the Honey-locust (*Gleditschia triacanthos*). The gall is formed of a single leaflet, folded in such a way as to assume the shape of a pod. Sometimes nearly all the leaves on the terminal twigs are deformed in this way. The fly completes its transformations within the gall and emerges in July and August.

Five examples. Coll. Am. Mus. Nat. Hist.

***Cecidomyia holotricha* Osten Sacken.**

PLATE XIV, FIG. 1.

Cecidomyia holotricha OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 193 ;
GLOVER, MS. Notes from my Journ. pl. xi, fig. 23.

This gall may be found through the summer on the underside of the leaves of the Shell-bark Hickory (*Hickoria ovata*), and also all other kinds of Hickories. Sometimes they cover the entire under surface of the leaf, which becomes deformed and gradually shrivels up from the injury done by the galls. The gall is subglobular, onion-shaped, and covered with a pubescence which is pale when the gall is young and growing, and becomes rust-colored when mature. It is hollow, and contains a single larva. Abundant everywhere in this vicinity.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia caryæcola* Osten Sacken.**

PLATE XIV, FIG. 2.

Cecidomyia caryæcola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192 ;
GLOVER, MS. Notes from my Journ. Dipt. pl. xi, fig. 24.

Pale green, smooth, elongated, onion-shaped, with the tip prolonged into a point. Found in clusters on the undersides of the leaves of different kinds of Hickories. Common.

Several examples. Coll. Am. Mus. Nat. Hist.

***Cecidomyia tubicola* Osten Sacken.**

PLATE XIV, FIG. 4.

Cecidomyia tubicola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192 ;
GLOVER, MS. Notes from my Journ. Dipt. pl. xi, fig 25.

These narrow, cylindrical, tube-like galls infest the underside of the leaves of different kinds of Hickories. They are inserted in a small protuberance on the leaf and break off very easily. When immature they are green, and when ripe they are blackish brown. Very common.

Four specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia sanguinolenta* Osten Sacken.**

Cecidomyia sanguinolenta OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 192.

This gall occurs in numerous clusters on the leaves of different species of Hickories. It is conical, somewhat narrowed at the base, and is of a blood-red or purplish color. Not common ; at Fort Lee, N. J., in July.

***Cecidomyia persicoides* Osten Sacken.**

PLATE XIV, FIG. 3.

Cecidomyia persicoides OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 193.

These curious excrescences are found on the underside of the leaves of different kinds of Hickories. The galls are variable in size and shape and are clothed with a delicate down like that of a peach, and look like a very diminutive fruit of this kind. Sometimes the galls grow along the mid-rib from one end to the other ; they then assume irregular shapes and entirely deform the leaf. They may be found fully developed in August. Common.

Three examples. Coll. Am. Mus. Nat. Hist.

***Cecidomyia strobiloides* Osten Sacken.**

PLATE XV, FIG. 1.

Cecidomyia strobiloides OSTEN SACKEN, Mon. Dipt. pt. I, p. 203 ; WALSH & RILEY, Am. Ent. Vol. I, p. 105 ; PACKARD, Guide to Study of Insects, p. 377 ; GLOVER, MS. Notes from my Journ. pl. xi, fig. 15.

Found plentifully in different localities in this vicinity, on the terminal twigs of various kinds of low Willows ; it is formed of

closely imbricated leaves, assuming the shape of a cone. The gall makes its appearance in April and May and is fully grown in July.

Several examples. Coll. Am. Mus. Nat. Hist.

***Cecidomyia brassicoides* Walsh.**

Cecidomyia brassicoides WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 577; WALSH & RILEY, Am. Ent. Vol. I, p. 105; PACKARD, Guide to Study of Insects, p. 377.

Found on Willow (*Salix longifolia*). The gall infests the tips of the twigs and consist of a more or less close-set bunch of leaves. The larva and perfect insect were described by Walsh (l. c.). Not common.

***Cecidomyia rigidæ* Osten Sacken.**

PLATE XV, FIG. 2.

Cecidomyia salicis FITCH, Journ. Agricul. & Sc. Vol. I, p. 263 (*name preoc.*).

Cecidomyia rigidæ (OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 189.

Cecidomyia siligna WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 591; RILEY, Am. Ent. Vol. II, p. 214; GLOVER, MS. Notes from my Journ. pl. xi, fig. 19.

This gall grows on the tips of the twigs of different kinds of Willows. It is a woody, elongated swelling, tapering to a point at the apex, and with a number of small terminal buds growing from it. It contains a single larva, which channels the gall from one end to the other. Common, especially on *Salix discolor*.

Six specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia batatas* Walsh.**

Cecidomyia batatas WALSH, Proc. Ent. Soc. Phil. Vol. III, p. 601.

The gall of this species infests the branches of the Willow (*Salix discolor*) and other species of Willow belonging to this group. It is hard and woody and varies considerably in size and shape; sometimes the different forms are strung together, one after the other, in more or less close proximity on the same twig. The shape of the gall is usually hemispherical, or irregularly ovate. Internally are numerous cells with orange-colored larvæ, which may be found from July to about March. Not common.

Four specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia clavula*, n. sp.**

PLATE XV, FIG. 5.

Found on the terminal twigs of the Dog-wood (*Cornus florida*). The gall is a club-shaped swelling about an inch long. Inside is an elongated channel, which is inhabited by a single orange-colored larva. In July I have taken this gall with the larva nearly fully grown, but did not succeed in raising it. The gall is very common on Staten Island. Also taken at Nyack, N. Y., by Rev. J. I. Zabriskie, who informs me that he also failed to rear the insect. In summer the gall is green and in winter it assumes the color of the bark of the twig.

Eight specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia impatientis* Osten Sacken.**

Cecidomyia impatientis OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 204 ; GLOVER, MS. Notes from my Journ. pl. xi, fig. 16.

Produces a round, succulent swelling at the base of the flower of *Impatiens fulva* in August. The gall is green, semitransparent and contains a number of cells inside. Not common. Taken at Mosholu, N. Y.

***Cecidomyia sambuci-umbellicola* Osten Sacken.**

Cecidomyia sambuci-umbellicola OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, pp. 52, 347.

Taken by Osten Sacken near South Orange, N. J., and at Tarrytown, N. Y., in June among the umbels of the common Elder (*Sambucus canadensis*). The gall is an enlargement of the buds of the flowerlets, and inside of each such bud is an orange larva. The perfect insect is unknown.

***Cecidomyia pilulæ* (Walsh).**

PLATE XV, FIG. 3.

Cynips pilulæ WALSH, Proc. Ent. Soc. Phil. Vol. II, p. 481.

Cecidomyia pilulæ WALSH & RILEY, Am. Ent. Vol. II, p. 29 ; RILEY, 5th Rep. U. S. Com. p. 206.

This gall is often so abundant that almost every leaf of the tree bears at least from five to seventy-five or more individuals.

and sometimes nearly all the leaves are studded with them. In the vicinity of New York it chiefly occurs on the Pin Oak (*Quercus palustris*) and Red Oak (*Quercus rubra*); but is also found on the Black-jack Oak (*Quercus nigra*), Scrub Oak (*Quercus ilicifolia*) and other species belonging to the Red Oak group. The gall when ripe is fleshy, but still solid, and when dry it is very hard and woody. Inside there are several cells inhabited by bright orange-red larvæ. The gall makes its appearance in May before the leaves are fully developed; it is then blister-like, yellow or pale brown, and is surrounded by a light green ring. When fully developed in August and September it is bright red or reddish brown. The gall varies greatly in size, shape and color. On the Red Oak, Scarlet Oak, and Black Oak (*Q. rubra*, *Q. coccinea* and *Q. tinctoria*) it is usually quite small, rounded and deep red, while on the Pin Oak (*Q. palustris*) it is much larger, greenish in color and looks almost like a different gall. On the Scrub Oak (*Q. ilicifolia*) the gall resembles that on Red Oak, but is much lighter in color. Frequently two or more galls are confluent and assume a very irregularly rounded or elongated form. The differences in appearance in this gall is accounted for by the behavior of the gall on different kinds of Oaks. On the under surface of the leaf the gall is indicated by a green nipple.

Cecidomyia symmetrica O. S., an authentic specimen of which I have before me, differs only from *C. pilule* by protruding symmetrically on both sides of the leaf, and probably after the gall maker is known will have to be referred to this species; for the present, however, it must stand as distinct until we have further knowledge on the subject. *Cecidomyia symmetrica* is, as far as I can ascertain, only found on the Spanish Oak (*Quercus falcata*), and has not yet been found in the vicinity of New York. It was described from the vicinity of Washington, D. C., by Osten Sacken (Mon. Dipt. N. Am., pt. I, p. 200), who also mentions *C. pilule*, but characterizes *C. symmetrica* as the species.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia poculum* Osten Sacken.**

PLATE XV, FIG. 4.

Cecidomyia poculum OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 201 ;
GLOVER, MS. Notes from my Journ. pl. xi. fig. 27.

The so-called Oak Spangles (*C. poculum*) are saucer-like outgrowths, which may be found in the latter part of the summer on the undersides of the leaves of the White Oak (*Quercus alba*), and, according to Osten Sacken, also on the Post Oak (*Quercus obtusiloba*). They vary in color from pale reddish to a light lavender, and generally occur in clusters, sometimes nearly covering the entire underside of the leaf. No insect has as yet been raised from the Oak Spangles in this country. Common.

Ten specimens. Coll. Am. Mus. Nat. Hist.

***Cecidomyia niveipila* Osten Sacken.**

Cecidomyia niveipila OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199.

Collected by me at Watchogue, Staten Island, in May, on the young leaves of the Red Oak (*Quercus rubra*). The gall consists of a large fold lined with a white pubescence on the inside. Sometimes the entire leaf is folded with the edges curled up, the underside of the leaf being the inside of the gall. I have found as many as fifteen larvæ in a single gall. The perfect insect is not known. Not common.

***Cecidomyia solidaginis* Loew.**

Cecidomyia solidaginis LOEW, Mon. Dipt. N. Am. pt. I, p. 194 ; GLOVER, MS. Notes from my Journ. pl. XII, fig. 32.

Infests the Golden-rod (*Solidago*), and is produced by the arrest of the stalk, which causes the leaves to accumulate, thus forming a globular bunch, consisting of several hundred leaves. Very common.

Numerous examples. Coll. Am. Mus. Nat. Hist.

***Cecidomyia carbonifera* Osten Sacken.**

Cecidomyia carbonifera OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 195 ;
GLOVER, MS. Notes from my Journ. XII, pl. 29, fig. 27.

Found in August on the leaves of Golden-rod (*Solidago*). The gall is a pale yellowish brown circular spot, surrounded by a blackish ring. The perfect insect is unknown. Common.

***Cecidomyia anthophila* Osten Sacken.**

Cecidomyia anthophila OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 302.

Taken in September, 1867, near Brooklyn, L. I., by Baron Osten Sacken, among the racemes of Golden-rod (*Solidago*). The gall is elongated-conical, blunt at the end and about one-third of an inch long. The surface is pale green, covered with a white down. Inside the gall is hollow and divided in two compartments by a delicate, somewhat funnel-shaped membrane, placed between about the middle of the cavity, point upward. The larva may be found at the bottom of the lower compartment.

***Cecidomyia viticola* Osten Sacken.**

Cecidomyia viticola OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202; WALSH, Am. Ent. Vol. II, p. 28; RILEY, 5th Rep. Nox. Ins. Mo. p. 119; SAUNDERS, Ins. Inj. Fruit, p. 292.

This gall is green or bright red, and narrow-elongate or conical in shape. It grows in numbers on the upper or lower side of the leaves of various kinds of Wild Grapes. Taken at Yonkers, N. Y., in July and August.

***Cecidomyia vitis-pomum* Walsh & Riley.**

Cecidomyia vitis-pomum WALSH & RILEY, Am. Ent. Vol. I, p. 106 (fig.); RILEY, 5th Rep. Nox. Ins. Mo. p. 114; PACKARD, Guide to Study of Insects, p. 378; SAUNDERS, Ins. Inj. Fruit, p. 296; GLOVER, MS. Notes from my Journ. pl. xi, fig. 17.

This gall grows on the stems of the Wild Grape, and is variable in size and shape; it is usually rounded, flattened at the base and pointed at the tip. When mature, it often has eight or nine longitudinal ribs as in a musk-melon, and is much smoother than when young. Inside are numerous longitudinal cells which are divided by a transverse partition. Not common.

***Lasioptera vitis* Osten Sacken.**

Lasioptera vitis OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 202; RILEY, 5th Rep. Nox. Ins. Mo. p. 117 (fig.).

Found on stems and leaf-stalks of the Wild Grape (*Vitis cordifolia*). The gall consists of a bunch of irregular swellings of various rounded shapes. The substance of the gall is soft, juicy, translucent; color yellowish green tinged with red or entirely of this color. Taken at Parkville, L. I., in June.

***Lasioptera farinosa* Osten Sacken.**

Lasioptera farinosa OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 204.

Produces a small, rounded woody swelling at the base of the leaflets or on the mid-rib of the common Blackberry (*Rubus villosus*). Not common.

***Asphondylia monacha* Osten Sacken.**

Asphondylia monacha OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 299.

Collected in September, 1867, near Brooklyn, L. I., on *Solidago altissima*, by Baron Osten Sacken, according to whom this gall is like that of *Cecidomyia solidaginis*, consisting of an accumulation of leaves upon a stem or branch, the growth of which has been stunted by the operation of the insect. But it may be separated from it by difference in the inner structure. The leaves forming the inner part of the gall of *A. monacha*, although stunted in their growth, have none of the characteristic appearance of the numerous narrow ribbon-like leaves surrounding the central cell in the gall of *Cecidomyia solidaginis*. (See Mon. Dipt. N. Am., Loew, pt. I. pl. i, figs. 9 and 10.)

***Asphondylia rudbeckiæ-conspicua* Osten Sacken.**

Asphondylia rudbeckiæ-conspicua OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. III, p. 51.

Taken at Mosholu, N. Y., in the latter part of July on the flower-heads of the Ox-eye Daisy (*Rudbeckia hirta*). Rare.

***Sciara ocellaris* (Osten Sacken).**

Cecidomyia ocellaris OSTEN SACKEN, Mon. Dipt. N. Am. pt. I, p. 199;

GLOVER, MS. Notes from my Journ. pl. xi, fig. 29.

Sciara ocellaris COMSTOCK, Rep. U. S. Dept. Agricul. 1881, p. 202.

Common on the leaves of the Red Maple (*Acer rubrum*). The gall is an eye-like, circular spot, light yellow in color with a red central dot. Sometimes it is entirely green or yellow. The perfect insect and earlier stages were described and figured by Prof. Comstock (l. c.). Common.

Two specimens. Coll. Am. Mus. Nat. Hist.

[December, 1892.]

TRYPETIDÆ.

Trypeta polita Loew.

Trypeta polita LOEW, OSTEN SACKEN, Trans. Am. Ent. Soc. Vol. II, p. 301.

The gall of this species is very common on *Solidago altissima* and other species of Golden-rods. It is caused by the arrest of the side branches and consists of a small bunch of accumulated, aborted leaves. Inside, at the base of the gall, is a hollow space in which the larva lives. The gall is a little over half an inch long, and sometimes as many as twenty-five occupy the end of the stalk.

Trypeta solidaginis (Fitch).

PLATE XV, FIG. 6.

Acinia solidaginis FITCH, 1st Rep. Nox. Ins. Trans. N. Y. State Agric. Soc. Vol. XIV, p. 771.

Trypeta solidaginis LOEW, Mon. Dipt. N. Am. p. 82; GLOVER, MS. Notes from my Journ. pl. xl, fig. 33.

This species produces a round gall on the stalk of the Golden-rod (*Solidago*). Inside it is of a pithy substance, in the centre of which the larva lives in a round cell. The gall is fully developed in August. Common.

Several specimens. Coll. Am. Mus. Nat. Hist.

HEMIPTERA.

PSYLLIDÆ.

Pachypsylla venusta Osten Sacken.

PLATE XVI, FIG. I.

Pachypsylla venusta OSTEN SACKEN, Stett. Ent. Zeit. 1861, p. 422; RILEY, 5th Rep. U. S. Ent. Com. p. 617 (fig.); Can. Ent. Vol. XV, p. 158.

Generally globular, but often more or less irregularly ovoid and very variable in size. The gall occurs on the petiole of the leaf of the Hackberry (*Celtis occidentalis*), and consists of an outer shell and an inner core which can be easily separated upon cutting the gall open. The apical portion of the gall has on one side a slit which is deepest and widest at the tip. The inner core

consists of thin brittle walls of the irregular cells which fill the inside of the outer shell. Taken by me near Peekskill, N. Y. Rare.

One specimen. Coll. Am. Mus. Nat. Hist.

***Pachypsylla celtidis-gemma* Riley.**

PLATE XVI, FIG. 3.

Pachypsylla celtidis-gemma RILEY, 5th Rep. U. S. Ent. Com. p. 618.

This gall occurs on the branches of the Hackberry (*Celtis occidentalis*), and is a deformation of the young bud which would form a new twig the ensuing year. It is variable in size and of irregular shape, but always bud-like and looking as if formed by the conglomeration of a number of rounded nodules. The gall is hard and woody with a number of cells inside. Common.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

***Pachypsylla celtidis-vesiculum* Riley.**

Pachypsylla celtidis-vesiculum RILEY, 5th Rep. U. S. Ent. Com. p. 618.

This gall appears on the upperside of the leaf merely as a flat, rounded blister of a yellowish or greenish color. On the underside, when fully grown, it is somewhat convex, with a small nipple in the center. The galls often occur in large numbers on the same leaf. Very common on the Hackberry (*Celtis occidentalis*).

Numerous specimens. Coll. Am. Mus. Nat. Hist.

***Pachypsylla celtidis-mamma* Riley.**

Pachypsylla celtidis-mamma RILEY, Johnson's Universal Encyclopedia, 1876; Can. Ent. Vol. XV, p. 158; 5th Rep. U. S. Ent. Com. p. 620 (fig.); FLETCHER, Rep. Ent. Soc. 1882, p. 79, 80.

Found on the leaves of the Hackberry (*Celtis occidentalis*). The gall on the upperside of the leaf is represented by a cup-shaped impression and on the underside is about 7 mm. high and about 5 mm. wide. In shape the gall is subcylindrical, with the apex bluntly rounded. Very common.

Several examples. Coll. Am. Mus. Nat. Hist.

***Pachypsylla celtidis-cucurbita* Riley.**

PLATE XVI, FIG. 2.

Pachypsylla celtidis-cucurbita RILEY, 5th Rep. U. S. Ent. Com. p. 621.

Very common in various localities in this vicinity on the leaves of the Hackberry (*Celtis occidentalis*). On the upperside of the leaf the gall forms a cup-shaped impression and on the underside a rounded swelling, truncated at the top and concave in the center at the apex with a very small nipple. Around the top of the gall there is usually an acute rim which surrounds the concave depression, and at the sides near the top is furnished with short ribs, which are sometimes nearly obliterated.

Numerous specimens. Coll. Am. Mus. Nat. Hist.

APHIDÆ.

***Hormaphis hamamelidis* Fitch.**

PLATE XVI, FIG. 5.

Bryocrypta hamamelidis FITCH, 4th Rep. State Cab. Nat. Hist. N. Y. p. 69.

Produces a conical gall on the upperside of the leaf of the Witch Hazel (*Hamamelis virginica*). Very common.

***Hormaphis spinosus* (Shimer).**

PLATE XVI, FIG. 4.

Hamamelistes spinosus SHIMER, Trans. Am. Soc. Vol. I, p. 284.

Hormaphis spinosus RILEY, Bull. U. S. Geo. Sur. (Hayden), Vol. V, p. 14 ;
THOMAS, 3d Rep. Nox. Ins. Illinois, p. 207.

This gall is a deformation of the fruit-bud of the Witch Hazel (*Hamamelis virginica*) and is covered with a number of rather long spines. It is green and has at the base a funnel-like exit. Central Park, N. Y. City, in July and August. Not common.

Four examples. Coll. Am. Mus. Nat. Hist.

***Colopha ulmicola* (Fitch).**

Byrsocrypta ulmicola FITCH, 5th Rep. Nox. Ins. Trans. N. Y. Agricul. Soc. 1858, p. 843.

Thelaxes ulmicola WALSH, Proc. Ent. Soc. Phil. Vol. I, p. 305 ; Am. Ent. Vol. I, p. 108.

Colopha ulmicola MONELL, Can. Ent. Vol. IX, p. 102.

Glyphina ulmicola THOMAS, 3d Rep. Nox. Ins. Ill. p. 142.

Colopha ulmicola RILEY, Bull. U. S. Geo. Sur. (Hayden), Vol. V, p. 9.

This species forms a cock's-comb-like gall on the upperside of the leaves of the White Elm (*Ulmus americana*) in June when the leaves are yet young. Common.

***Pemphigus rhois* Fitch.**

PLATE XVI, FIG. 6.

Pemphigus rhois WALSH, Am. Ent. Vol. I, p. 108; THOMAS, 3d Rep. Nox. Ins. Ill. p. 152; PACKARD, Guide to Study of Insects, p. 524.

The gall of this species occurs on the underside of the leaves of the Smooth Sumac (*Rhus glabra*) and Staghorn Sumac (*Rhus typhina*). It somewhat resembles a tomato in shape, and is of a yellowish green color tinged with red. It is fully grown in August, and the insects inside are fully developed in September. Common.

Two examples. Coll. Am. Mus. Nat. Hist.

***Pemphigus populicaulis* Fitch.**

Pemphigus populicaulis FITCH, 5th Rep. Nox. Ins. N. Y. Trans. Agric. Soc. 1858, 845; LEBARON, 3d Rep. Nox. Ins. Ill. 1873, p. 193; THOMAS, 3d Rep. Nox. Ins. Ill. (Trans. Dept. Agric. 1878), p. 149, WALSH & RILEY, Am. Ent. Vol. I, 2d Ser. 1880, p. 206; PACKARD, 5th Rep. U. S. Ent. Com. p. 471.

This species forms an irregularly rounded, green gall, at the junction of the stem and leaf of the Poplar (*Populus monilifera*). On the underside the gall is provided with a mouth-like orifice. Common at Passaic, N. J.

***Phylloxera caryæcaulis* (Fitch).**

Pemphigus caryæcaulis FITCH, 1st Rep. Nox. Ins. Trans. N. Y. Agric. Soc. 1854, p. 859.

Phylloxera caryæcaulis THOMAS, 3d Rep. Nox. Ins. Illinois, p. 106; PACKARD, 5th Rep. U. S. Ent. Com. p. 322.

This species is found upon the twigs and leaf-stalks of different kinds of Hickories. It forms a hollow, green, bullet-like gall of a leathery texture. When fully grown it opens and becomes cup-shaped. The gall makes its appearance in May and early in June. Very common,

ARACHNIDA.

Acarus serotinæ, n. sp. (?)

PLATE XVI, FIG. 7.

This gall is produced by a mite (*Acarus*) and is probably undescribed. It occurs on the upperside of the leaves of the Wild Cherry (*Prunus serotina*) and is quite common in this neighborhood. The gall is about two-fifths of an inch long, and is a stem-like tube which expands into a pouch-like sac at the end. It is hollow, with an exit on the underside of the leaf. I name it provisionally *Acarus serotinæ*.

Several examples. Coll. Am. Mus. Nat. Hist.

EXPLANATION OF PLATES.

PLATE IX.

- | | |
|---------------------------------------------------|-------------------------------------------------------|
| <i>Fig. 1.</i> Rhodites bicolor (<i>Harr.</i>). | <i>Fig. 5.</i> Rhodites dichlocerus (<i>Harr.</i>). |
| " 2. " ignota O. S. | " 6. " verna O. S. |
| " 3. " radicum O. S. | " 7. Diastrophus bassettii <i>Bent.</i> |
| " 4. " globulus <i>Bent.</i> | |

PLATE X.

- | | |
|------------------------------------------------|----------------------------------------------------------|
| <i>Fig. 1.</i> Diastrophus cuscuteformis O. S. | <i>Fig. 4.</i> Amphibolips confluentus (<i>Harr.</i>). |
| " 2. " nebulosus O. S. | " 5. " inanis (O. S.). |
| " 3. Andricus cornigerus (O. S.). | " 6. " ilicifoliae (<i>Bass.</i>). |

PLATE XI.

- | | |
|------------------------------------------|------------------------------------------------------|
| <i>Fig. 1.</i> Andricus futilis (O. S.). | <i>Fig. 4.</i> Andricus singularis (<i>Bass.</i>). |
| " 2. " similis (<i>Bass.</i>). | " 5. " lana (<i>Fitch.</i>). |
| " 3. " clavula (<i>Bass.</i>). | " 6. Cynips (?) prinoides <i>Bent.</i> |

PLATE XII.

- | | |
|-----------------------------------------------------|------------------------------------------------------|
| <i>Fig. 1.</i> Acraspis erinacei (<i>Walsh.</i>). | <i>Fig. 4.</i> Holcaspis globulus (<i>Fitch.</i>). |
| " 2. Neuroterus floccosus (<i>Bass.</i>). | " 5. " duricoria <i>Bass.</i> |
| " 3. Dryophanta polita (<i>Bass.</i>). | " 6. Cynips strobilana O. S. |

PLATE XIII.

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|------------------------------------------------------|--------------------------------------------------------|
| <i>Fig. 1.</i> Neuroterus batatus (<i>Fitch.</i>). | <i>Fig. 3.</i> Biorhiza forticornis (<i>Walsh.</i>). |
| " 2. Andricus petiolicola (<i>Bass.</i>). | " 4. Cecidomyia serrulatæ O. S. |

PLATE XIV.

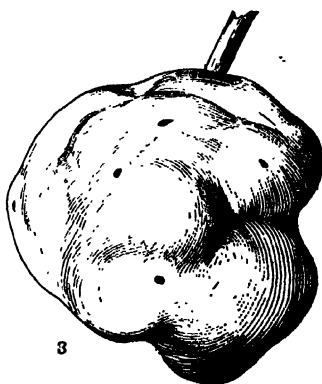
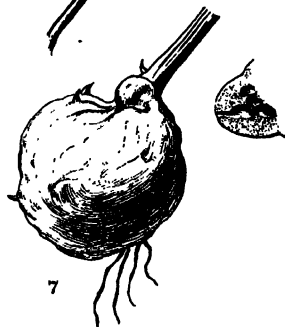
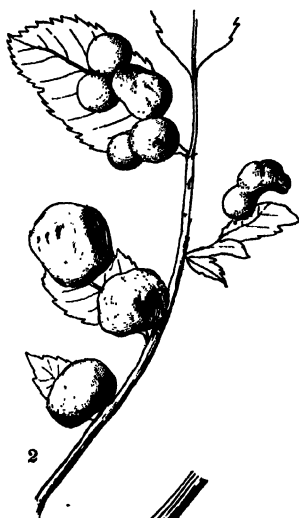
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|--------------------------------------------|---------------------------------------------|
| <i>Fig. 1.</i> Cecidomyia holotricha O. S. | <i>Fig. 3.</i> Cecidomyia persicoides O. S. |
| " 2. " caryæcola O. S. | " 4. " tubicola O. S. |

PLATE XV.

- | | |
|----------------------------------------------|-----------------------------------------|
| <i>Fig. 1.</i> Cecidomyia strobiloides O. S. | <i>Fig. 4.</i> Cecidomyia poculum O. S. |
| " 2. " rigidæ O. S. | " 5. " clavula <i>Bent.</i> |
| " 3. " pilulæ (<i>Walsh.</i>). | |

PLATE XVI.

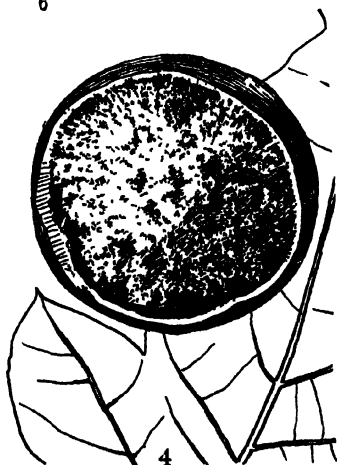
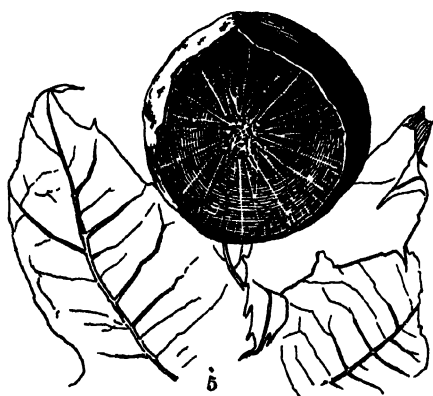
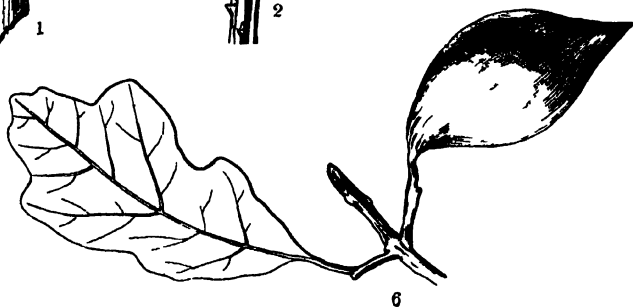
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|---------------------------------------------|----------------------------------------------------|
| <i>Fig. 1.</i> Pachypsylla venusta O. S. | <i>Fig. 5.</i> Hormaphis hamamelidis <i>Fitch.</i> |
| " 2. " cucurbita <i>Riley.</i> | " 6. Pemphigus rhois <i>Fitch.</i> |
| " 3. " gemma <i>Riley.</i> | " 7. <i>Acarus serotinæ</i> <i>Bent.</i> |
| " 4. Hormaphis spinosus (<i>Shimer.</i>). | |



1. *Rhodites bicolor* Harr.
2. " *ignota* O. S.
3. " *radicum* O. S.

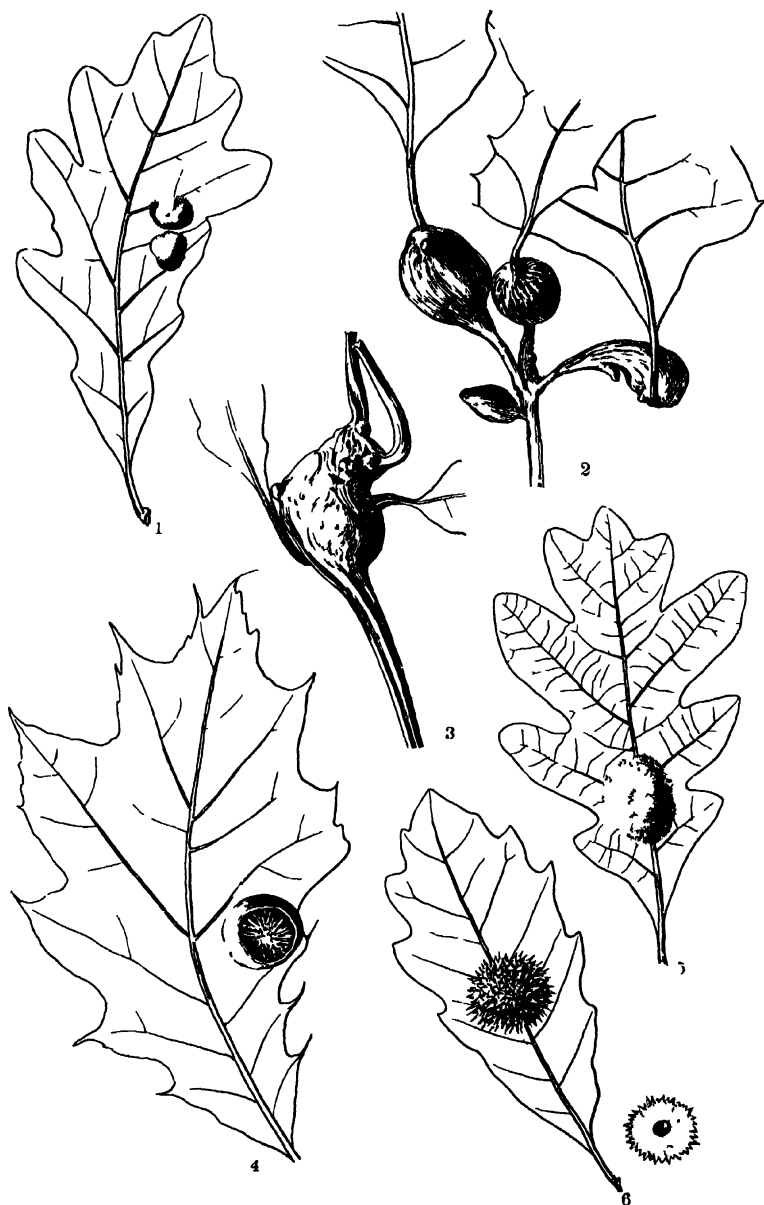
7. *Diastrophus bassettii* Beut.

4. *Rhodites globulus* Beut.
5. " *dichlocerus* Harr.
6. " *verna* O. S.



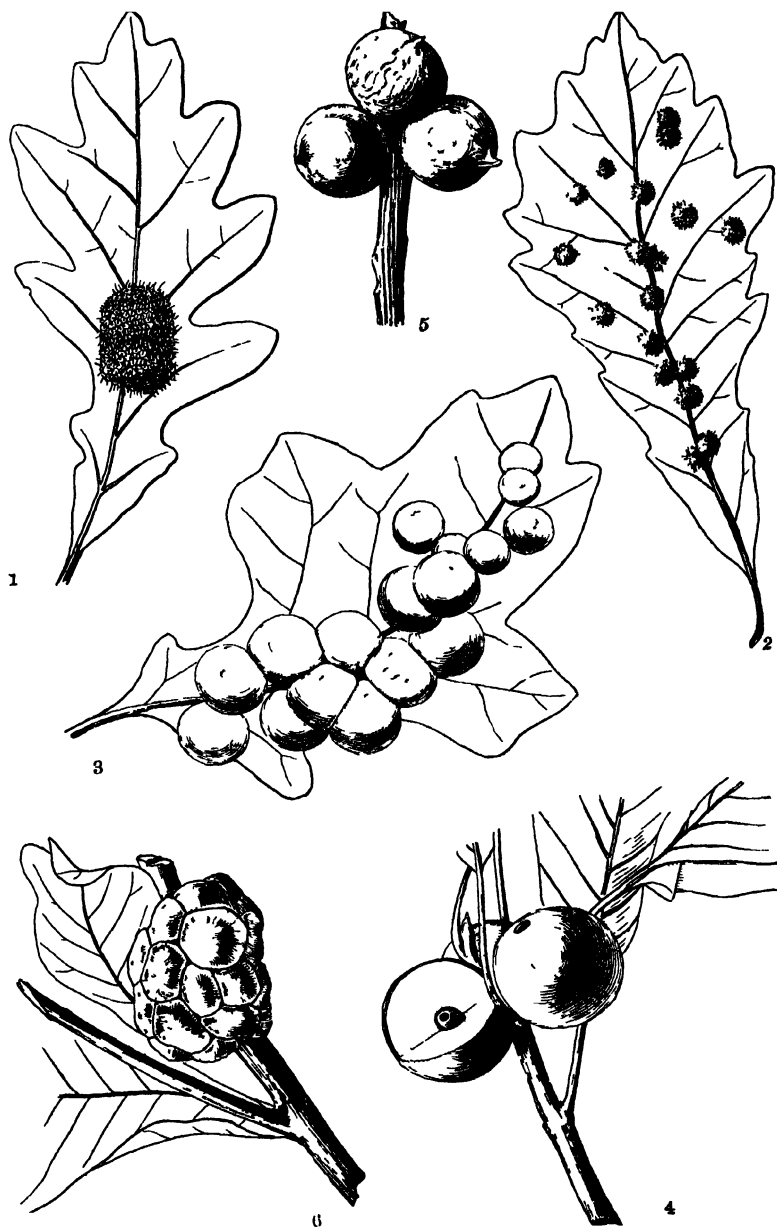
1. *Diastrophus cuscuteformis* O. S.
2. " *nebulosus* O. S.
3. *Andricus cornigerus* O. S.

4. *Amphibolips confluentus* Harr.
5. " *inanis* O. S.
6. " *silicifoliae* Basa.



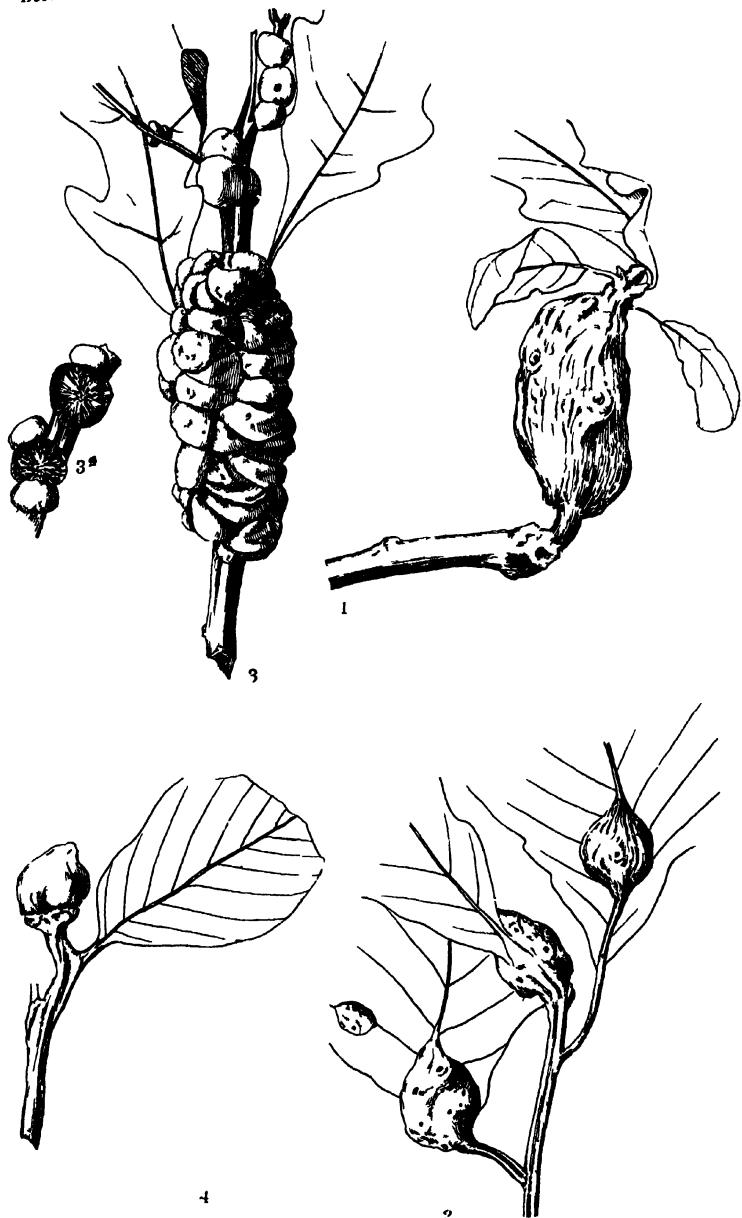
1. *Andricus futilis* O. S.
2. " *similis* Bass.
3. " *clavula* Bass.

4. *Andricus singularis* Bass
5. " *lana* Fitch.
6. *Cynips* (?) *pinoides* Beut.



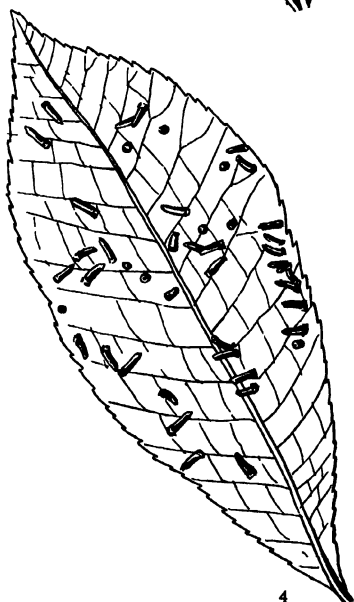
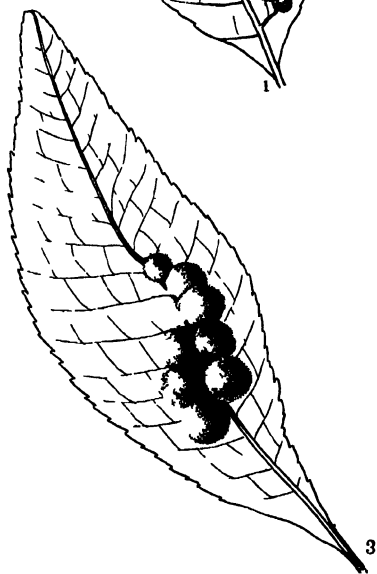
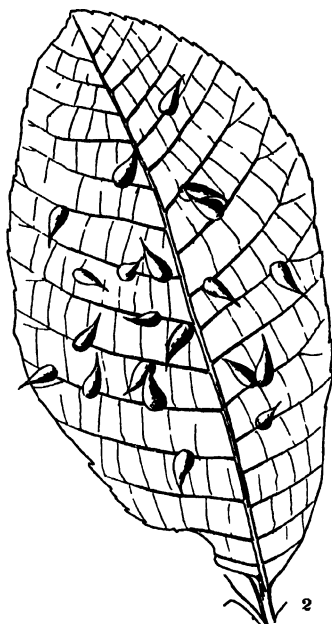
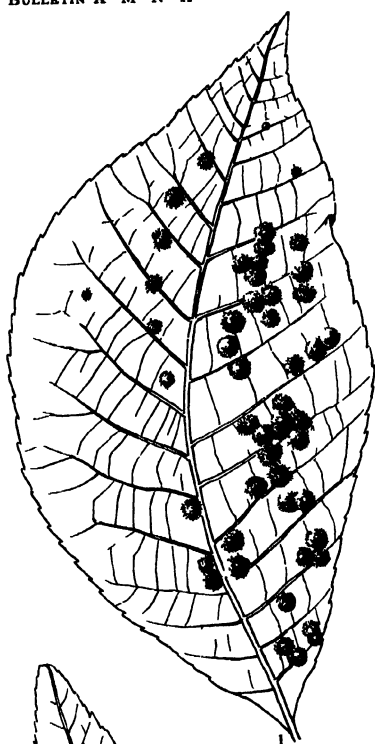
1. *Acraspis erinacei* Walsh.
2. *Neuroterus floccosus* Bass.
3. *Dryophanta polita* Bass.

4. *Holcaspis globulus* Fitch.
5. " *duricoria* Bass.
6. *Cynips strobilana* O. S.



1 *Neuroterus batatus* Fitch
2 *Andricus petiolicola* O S

3 *Biorhiza forticornis* Walsh
4 *Cecidomyia serrulatae* O S



1 *Cecidomyia holotricha* O S
2, " *caryæcola* O S,

3 *Cecidomyia persicoides* O S
4 " *tubicola* O, S,



1. *Cecidomyia strobiloides* O. S.

2. " *rigidæ* O. S.

5. *Cecidomyia clavula* Beut.

3. *Cecidomyia pilulæ* Walsh.

4. " *poculum* O. S.

6



1. *Pachypsylla venusta* O. S.
 2. " *curcubita* Riley.
 3. " *gemma* Riley.

7. *Acarus serotinae* Beut.

4. *Hormaphis spinosus* Shimer.
 5. " *hamamelidis* Fitch.
 6. *Pemphigus rhois* Fitch.

**Article XVI.—NOTES ON BIRDS AND MAMMALS
OBSERVED NEAR TRINIDAD, CUBA, WITH RE-
MARKS ON THE ORIGIN OF WEST INDIAN
BIRD-LIFE.**

By FRANK M. CHAPMAN.

INTRODUCTORY.

Trinidad is situated on the southern coast of Cuba, about 400 miles from the eastern, and 350 from the western extremity of the island. The shore at this point is formed of recent coral limestone. Three miles inland this has been upheaved, and appears as a line of hills parallel to the coast, about thirty miles in length and reaching an altitude of 900 feet.

From the summits of this coast-range one looks north across the noble valley of Trinidad. This valley is three miles in width and about thirty in length. Its southern boundary is formed by the low range just mentioned, while its northern side is defined by the foot hills of the San Juan Mountains. It is celebrated for its fertility, and is, or has been, almost entirely devoted to sugar-cane plantations. The San Juan Mountains are largely formed of a palæozoic limestone. They are irregular and picturesque in outline and seamed by narrow valleys, down which dash clear mountain streams on their way to the sea. Their average height is from 2500 to 3000 feet, and one peak, Portrerillo, reaches an altitude of 4000 feet.

The region about Trinidad, then, may be divided into three quite different districts: first, the coast, including the southern slope of the coral limestone hills; second, the Trinidad Valley; third, the San Juan Mountains. During the month and a half (March 1–April 14, 1892) in which I collected in this region I visited localities in each of the districts mentioned, and a description of them will serve also for the districts in which they are included. They may be considered in natural, or what proved to be the reverse, order in which they were visited.

Casilda (April 10-14).—Casilda is the port of Trinidad. The harbor is formed by a crescentic-shaped sand-bar which reaches out from the shore and partly encloses a basin about two miles in diameter. On the sea side there is a hard, fine beach; on the bay side there are extensive mangrove swamps and large grassy marshes. The place seemed admirably adapted to support an aquatic avifauna, which nevertheless was largely wanting. Brown Pelicans and Cormorants were not uncommon, and Clapper Rails were apparently numerous in the mangroves. Beyond these I did not observe ten individuals of any species of water bird. The distance from the coast to the summit of the coast hills, near which is situated the city of Trinidad, is between three and four miles. The growth here is scattered, low and scrubby, the absence of royal palms being especially noticeable. Birds are comparatively rare.

Guanayara (April 5-9).—Guanayara is at the base of the mountains, eight miles west of Trinidad. There is no beach here, and the sea breaks on a solid wall of conglomerate coral limestone. At a distance of about one mile from the shore this formation meets the palæozoic rocks of the mountains. The line of connection is clearly marked by the royal palms which grow at the extreme edge of the older formation, but, as on the coast-range at Trinidad, this tree was not found in the recent coral limestone. My collecting here was largely limited to the newer land which flanks the mountains. On this tract the growth presents every gradation from the recently established running vines and hardy *Borricha*, growing within ten feet of the sea, to woods resembling second-growth with dense thickets underneath. Birds of certain species were abundant, but there were wanting a number of species found at both San Juan and San Pablo.

San Pablo (March 15-30).—San Pablo is in the Trinidad Valley, fifteen miles east of Trinidad. The valley is largely devoted to raising sugar and tobacco, but there are great tracts of fallow land given up to grazing and resembling northern pastures, and, where the cattle are not numerous, they are covered with a growth of guava bushes. At this point the valley is traversed by the Agabama River, in the winter a shallow stream

about fifty feet in width and with treeless banks. San Pablo is on the northern side of the valley, near the foothills of the San Juan chain. These low hills and their intervening valleys are generally well wooded, and in the latter are small streams bordered by a more or less dense tropical growth. Localities of this nature furnished the best collecting ground. Indeed the great diversity of ground at San Pablo gave rise to a richer avifauna than I found at any other place. In the 'old fields' of the valley were Meadowlarks and Yellow-winged Sparrows; on the Agabama were Jacanas and Gallinules, and in the guavas and wooded hills and valleys were found all the species of woodland birds which I observed in Cuba.

San Juan de Letran (March 1-13).—The valley of San Juan is eight miles north of Trinidad at an altitude of 2000 feet in the San Juan Mountains. It is one of many small valleys, averaging a quarter of a mile in width, enclosed by the mountain tops, which at this point were about four hundred feet above the level of the valley. The summits and sides of the mountains were here covered by a dense growth of high, wiry grass, and numerous but scattered small palmettoes, and a species of agave bearing a yellow flower which was abundant at the time of my visit. As a rule each valley is watered by a clear mountain stream, and when the ground is not under cultivation by the mountaineers, it supports a fairly dense vegetation. Royal palms, averaging about sixty feet in height, are here, as elsewhere, the most abundant and characteristic trees.

San Juan was the realization of a naturalist's dream of the tropics. With the kindly hospitality, which I everywhere encountered, a resident mountaineer placed an unoccupied thatched cabin at my disposal, and having a young native to cook for me, I was thus most favorably situated for collecting. The nature of the country, too, was such as to focus the birds within comparatively narrow limits, and for this reason they were exceedingly abundant. In or near the clearing about my house grew royal and cocoa palms, mangoes, bananas, oranges, lemons, guavas and coffee, and from my door I saw, with few exceptions, all the species of birds I observed in the mountains. Altitude here has apparently no influence on the distribution of birds.

The absence at San Juan of certain species found at San Pablo was evidently due to purely local conditions; as for example, the lack of large fields suitable for Meadowlarks, or of a body of water suitable for the habitation of Jaçanas.

During my stay at or near Trinidad I was everywhere so hospitably received I have difficulty in fitly expressing my thanks. Mr. B. W. Morrill, Sres. Eduardo Caret and Manuel Fernandez, Sarjento Prats of the Guardia Civil, and Captain White of the American Schooner 'City of Philadelphia,' all rendered me invaluable assistance, which I desire to gratefully acknowledge; and I would especially thank Mr. Daniel Quayle, the American Consular Agent at Trinidad, whose home and services were always freely offered me.

I.—NOTES ON CUBAN BIRDS.

General Impressions of Cuban Bird-life.—One familiar with the bird-life of only the middle Atlantic States of America would, I think, return from a morning in the woods of San Juan or San Pablo with three prominent impressions of Cuban birds; first, their abundance; second, their comparative tameness; third, their lack of song power. Probably the second characteristic contributes to the force of the first. Of some eighty species found at San Pablo it was customary to observe about two-thirds each day, while in the vicinity of New York City it is not usual to observe more than one-third of the summer-resident fauna during a day's outing.

The restrictions imposed by the government on the use of fire-arms, the high price charged for ammunition, and the absence of game, except Quail and Doves, are excellent reasons why there should be little shooting in Cuba, and during my stay I encountered but three gunners, all of whom were hunting Doves (*Zenaidura*, *Zenaida* and *Columba corensis*). Birds, therefore, are molested but little, and as a result many of them display an unusual confidence in their human neighbors. For this reason, and also because of their abundance and continuous presence, they are far better known to the natives of all classes than are

our common birds. The inhabitants of the country were particularly well informed, and seldom failed to recognize the permanent resident birds, either by their appearance or notes. Children of not more than eight years of age could generally name at sight most of the birds on my work table. A general knowledge of resident birds, however, was not confined to the inhabitants of the country, and on one occasion, in a restaurant in Trinidad, I was somewhat surprised to hear a discussion on the identity of the Flycatcher, known as Pitirre (*Tyrannus dominicensis*), while the debate over the bird's time of arrival from the south became animated.

In saying that Cuban birds displayed a lack of song power I would not imply that they lack in vocal power; on the contrary, many of them are exceedingly noisy, and the woods and clearings resound with strange and sometimes not unmusical call-notes, cries and whistles. At San Juan the clearings, low growth and woods were in close proximity, and, as before stated, birds were more abundant here than elsewhere. The morning chorus was opened by the soft, plaintive cooing of the Zenaida and Zenaidura Doves and the more vigorous notes of the Torcaza. They were followed by the singular call-notes and whistles of the two Black-birds (*Quiscalus* and *Ptiloxena*). Then the chattering notes of the Guatibero (*Pitangus*), the rolling call of the Carpintero (*Centurus*), the attempt at song of the Zorzal (*Mimocichla*) were added to the chorus; while at intervals one heard the *kr-r-row* of Trogons, the complaining note of the Anis, the mournful whistle of the diminutive Siju Owl, or the grating cries of a passing flock of Paroquets.

In the open valley at San Pablo birds were of course less abundant, and the characteristic species here were the Carolina Doves and Meadowlarks.

At the time of my visit woodland birds were feeding on the fruit of the cupey tree, and were always abundant in the vicinity of trees bearing ripe fruit.

On one occasion, while sitting beneath one of these trees, I heard or saw on or near it, within a period of ten minutes, eighteen species of birds, of which all but two, the Black-throated Blue Warbler and Black-whiskered Vireo, were peculiar to Cuba.

They included three species of Woodpeckers, three of Black-birds, two Flycatchers (*Pitangus* and *Myiarchus*), Crows, Parrots, Paroquets, Trogons, Negritos, Zorzals and Todies.

Although I observed some twenty species of the North American land-birds which occur in Cuba during the winter only, the part played by these birds in the avifauna was, with five exceptions, an unimportant one.

These five birds mentioned, in the order of their abundance, were Black-throated Blue, Palm and Prairie Warblers, Redstarts, and Catbirds.

The nesting season among the Passeres in Cuba is apparently not fairly under way until after the middle of April. Some species commence to breed in March, but the real breeding season was evidently about to open at the time I left Guanayara. Early in March, however, I observed that birds which do not nest until late in April were in pairs. It seems not improbable that some of these sedentary insular species may be mated for life.

The Migration.—Beyond the arrival of three species, which are found in Cuba during the summer only; I observed no evidences of a migration. There were apparently no flights of transients *en route* to the North, and no marked fluctuation in the numbers of the winter visitants was noticed.

It is probable that by far the larger number of migrants which touch Cuba in going from the United States go to the westward and cross from Cape San Antonio to Yucatan in preference to following the Cuban coast to the eastward and thence continuing their journey through Jamaica, or San Domingo, Porto Rico and the Lesser Antilles. In returning in the spring it is natural to suppose they would retrace the course of the previous fall.

Birds Observed while Sailing from Batabanó to Trinidad.—Few birds were observed while sailing along the southern coast of Cuba. From Cienfuegos to the bar which makes the harbor of Trinidad, the shore is an almost continuous wall of coral limestone; there are no shoals or sandy beaches and no birds were seen. Between Cienfuegos and Batabanó the water is shallow, and there are innumerable mangrove islands varying in size from the

small sand-bar, on which a few mangrove shoots had but recently taken root, to the older islands having an area of thirty or forty acres. One would expect to find water-birds here in abundance, but seven Laughing Gulls, several hundred Cormorants, about fifty Frigate Birds, a few Brown Pelicans, and two great White Herons (*Ardea occidentalis*), were the only ones observed.

The Cuban Avifauna.—It is largely to that fine old naturalist, Dr. Juan Gundlach, that we owe our knowledge of Cuban birds. For fifty-four years he has pursued his studies of the Cuban fauna, and from his report on the birds' I make the following analysis:

Total number of species recorded.....	257
Land-birds.....	156
Water-birds.....	101
Permanent residents.....	130
Transient visitants.....	39
Winter residents.....	81
Summer residents.....	7

The number of species peculiar to the island, and a comparison of the extent of the avifauna with that of other West Indian Islands, will be found in a succeeding part of this paper.

In two genera, *Teretistris* and *Mimocichla* (see remarks under the latter) species ranging throughout Cuba seem to have become differentiated into two well-marked forms, an eastern and a western. Careful comparison of large series of birds will doubtless show that other wide ranging Cuban species are perhaps separable into eastern and western races.

Species Described as New or Added to the Cuban Fauna.—In the present paper the following species and subspecies are described as new or described under new names: *Rallus longirostris cubanus*, *Columbigallina passerina terrestris*, *Pitangus jamaicensis*, *Dendroica petechia flaviceps*, *Capromys columbianus*. "*Dives*" *atroviolaceus* is placed in a new genus *Ptiloxena*. *Colinus virginianus floridanus* is added to the Cuban fauna, and the Red-tailed Hawk is given as *Buteo borealis calurus*.

¹ Journ. fur Orn., XIX, 1871, pp. 265-295, 353-378; XX, 1872, pp. 401-432; XXII, 1874, pp. 113-166, 286-308; XXIII, 1875, pp. 293-340, 353-407.

ANNOTATED LIST OF BIRDS OBSERVED.

In the following notes on birds observed near Trinidad the expressions abundant, common, etc., without mention of locality, refer to Guanayara, San Pablo and San Juan when applied to land-birds, and to Casilda when applied to water-birds.

When no doubt of identity existed I have given the local native name. In other cases I have given in quotation marks the native name from Gundlach's 'Beiträge zur Ornithologie Cubas' (l. c.). When practicable this is followed by the English equivalent.

1. *Colymbus dominicus* Linn. ZARAMAGULLON CHICO. ST. DOMINGO GREBE.—Two pairs of this little Grebe were found in the Trinidad River near its headwaters in the San Juan valley. The river at this point is a mere mountain stream, which in places widens into small pools. A female taken March 4 was molting and had lost all the quills of both wings.

2. *Podilymbus podiceps* (Linn.). ZARAMAGULLON GRANDE. PIED-BILLED GREBE.—Several observed at San Pablo.

3. *Sterna maxima* Bodd. "GAVIOTA." ROYAL TERN.—Not common.

4. *Anhinga anhinga* (Linn.). "MARBELLA." ANHINGA.—But two observed.

5. *Phalacrocorax dilophus floridanus* (Aud.). "CORUA." FLORIDA CORMORANT.—Common.

6. *Pelecanus fuscus* Linn. "ALCATRAZ." BROWN PELICAN.—Common.

7. *Fregata aquila* (Linn.). "RABIHORCADO." MAN-O'-WAR BIRD.—Not uncommon. During a severe storm on March 7 three of these birds were seen at San Juan. The wind was blowing the sea mist rapidly across the tops of the mountains, but high above these lower clouds the Man-o'-War Birds floated calmly, apparently undisturbed by the elements.

8. *Anas discors* Linn. BLUE-WINGED TEAL.—One seen at San Pablo.

9. *Aix sponsa* (Linn.). PATO DE LA FLORIDA.¹ WOOD DUCK.—Two pairs of these birds frequented a forest brook at San Pablo. A pair taken March 19 had the sexual organs but slightly enlarged. They were said by the natives not to remain during the summer.

10. *Ardetta exilis* (Gmel.). "GARZITA." LEAST BITTERN.—One specimen taken in the mangroves at Casilda.

11. *Ardea occidentalis* Aud. "GARCILOTE BLANCO." GREAT WHITE HERON.—One observed at Casilda.

12. *Ardea wardi* Ridgw. WARD'S HERON.—Observed on several occasions, but no specimens were secured. It is more than probable, however, that the Cuban bird should stand as *wardi* rather than *herodias*.

13. *Ardea egretta* Gmel. GARZA BLANCA. AMERICAN EGRET.—There was a flock of about twenty of these birds at San Pablo which came each night to roost in a tree at the border of the river. They appeared in a body with much regularity just after sunset, and after circling about the tree once or twice alighted on its branches. One now heard a low croaking chorus as the birds selected perches and settled themselves for the night. This rookery was but 200 yards from the houses and mill of the estate, and not more than sixty feet from a well-travelled road. The confidence thus displayed by the birds in their choice of a roost was in striking contrast with the habits of the shy, much-hunted Egret of Florida. During the day single birds were sometimes observed in cane-fields from which the cane had been cut. They were doubtless feeding on the lizards which abounded in ground of this nature.

14. *Ardea cœrulea* Linn. GARZA AZUL. LITTLE BLUE HERON.—Not uncommon.

15. *Ardea tricolor ruficollis* (Gosse). LOUISIANA HERON.—About twenty were observed at Casilda.

16. *Ardea virescens* Linn. "AGUAITA CAIMAN." GREEN HERON.—Common along mountain streams.

¹ Dr. Gundlach applies this name to the preceding species, calling the Wood Duck "Huyuyo."

17. *Nycticorax nycticorax nævius* (Bodd.). "GUANABÁ DE LA FLORIDA." BLACK-CROWNED NIGHT HERON.—Two observed at Casilda.

18. *Aramus giganteus* (Bonap.). GUARACAO. LIMPKIN.—A common bird at San Pablo, where they frequented the guava-grown uplands, probably to feed on land-shells. They were exceedingly wary. They were rarely, if ever, heard calling during the day, but soon after nightfall and throughout the night one could hear the weird cry from which they receive their native name.

19. *Rallus longirostris cubanus*, subsp. nov.

"GALLINUELA." CUBAN CLAPPER RAIL.

Char. Subsp.—Intermediate in coloration between *Rallus longirostris caribæus* Ridg. and *Rallus longirostris scotti* Senn. Of a darker and less reddish shade of brown, and with less white on the abdomen than *caribæus*; not so dark as *scotti*.

Description of Type (No. 57,391, Coll. Am. Mus. Nat. Hist., adult male, Casilda, coast of southern Cuba, April 14, 1892. Collected by Frank M. Chapman, Collector's No. 2707).—Upper parts dark sepia brown, the feathers of the back bordered laterally with olivaceous gray; wings and tail of a lighter brown than the back; tertials slightly darker than the back and with the lateral margins grayer; a buff superciliary stripe; lores and subocular region blackish; post-ocular region gray; chin and throat white bordered by deep buff, which on the neck has a grayish tinge and on the entire breast becomes cinnamon; flanks and under tail-coverts of nearly the same color as the wings, the feathers with narrow transverse white bands bordered by blackish areas; middle of the abdomen whitish, the feathers with indistinct, transverse dusky bands. Wing, 5.98 in.; tarsus, 2.14; culmen, 2.44; depth of bill at posterior margin of nostril, .41 in.

Description of Female (No. 57,389, Coll. Am. Mus. Nat. Hist. Same date, locality, and collector. Collector's No. 2702).—Similar to the male but smaller, the sides of the throat, neck and breast paler. Wing, 5.20; tarsus, 1.90; culmen, 2.18; depth of bill at posterior margin of nostril, .38 in.

Six specimens of this new Rail were collected at Casilda. Two of these are fully-grown young of the year, which differ from the adults only in having the throat and chin buffy instead of white.

For comparison with these birds I have had, through the courtesy of Messrs. Brewster, Ridgway and Sennett, specimens of

caribæus, *scotti*, and also one example of *saturatus*. This included the type of *caribæus*, while in the American Museum Collection there are the types of *scotti* and one example of true *longirostris* from Bahia. Comparison of *cubanus* with this material shows that while it is more closely related to *scotti* than to any known form it evidently connects *scotti* with *caribæus*. Thus the darkest Cuban example is inseparable from a pale specimen of *scotti*, and on the other hand the palest Cuban birds are scarcely distinguishable from the darkest specimens of *caribæus*. From *saturatus*, *cubanus* is apparently separated by its browner color and gray instead of brown margins to the feathers.

I have provisionally adopted Mr. Sennett's nomenclature for *crepitans* and *saturatus*,¹ but, as previously stated by Mr. Brewster and myself,² I believe that a larger number of specimens than we at present possess will show a complete intergradation between all the forms of this group, with the probable exception of the Bahaman *Rallus coryi*.

The Cuban Clapper Rails were common in the mangroves at Casilda. The breeding season was evidently over before April 14, for on that date I secured the two fully-grown young birds before mentioned.

20. *Gallinula galeata* (Licht.). GALLINETA. FLORIDA GALLINULE.—Common in pairs at San Juan.

21. *Tringa minutilla* Vieill. "ZARAPICO." LEAST SAND-PIPER.—One observed at Casilda.

22. *Symphemia semipalmata* (Gmel.). "ZARAPICO REAL." WILLET.—A flock of eight was observed at Casilda. None were secured, and it is possible they may have belonged to the western race *inornata*.

23. *Actitis macularia* (Linn.). "ZARAPICO." SPOTTED SAND-PIPER.—Not uncommon at San Pablo.

24. *Charadrius squatarola* (Linn.). BLACK-BELLIED PLOVER.—One observed at Casilda.

¹ Auk, 1888, p. 161.

² *Ibid.*, 1889, p. 136.

25. *Ægialitis vocifera* (Linn.). "FRAILECILLO." KILDEER.—Not common.

26. *Ægialitis wilsonia* (Ord). "FRAILECILLO." WILSON'S PLOVER.—A pair of breeding birds was taken at Guanayara. The male is in fully adult plumage, but lacks the cervical collar, which in most high-plumaged specimens of this species is nearly complete.

27. *Jacana spinosa* (Linn.). GALLITO. MEXICAN JACANA.—Found only at San Pablo, where they were not uncommon along the Agabama River. Here they feed among small lily-pads not more than two inches in diameter, growing in water several feet deep. If they paused the leaves sank beneath them, when they would take to the water, swimming easily and somewhat like a Coot (*Fulica*).

28. *Colinus virginianus cubanensis* (Gld.). CODORNIZ. CUBAN BOB-WHITE.—Two males and a female of this bird were taken from a small flock in the mountains.

29. *Colinus virginianus floridanus* (Coes). CODORNIZ. FLORIDA BOB-WHITE.—Six Quails were secured at San Pablo, where they were apparently not uncommon. They frequented the guavas, cane-fields and tobacco plantations. The familiar *bob-white* and 'scatter calls' were first heard on March 23, when the birds were still in flocks and evidently just beginning to mate.

Of four males one is typical of the very dark Quail from southern Florida, while the other three are intermediate between this form and true *cubanensis*. The two females apparently agree with the Florida bird, and are easily distinguishable from the females of true *cubanensis*.

I can account for the presence of these birds only on the supposition that Florida Quails have at some time been introduced in Cuba, and that they have interbred with the native birds. The explanation is not unreasonable, for we know that Quail have been introduced into other West Indian Islands.¹

¹Cf. Gundlach, J. f. O., 1874, p. 300. Dr. Gundlach, however, confused the two birds, for I have seen specimens of true *cubanensis*, and one equally typical of the Florida bird, which had been collected by him in Cuba and labeled *cubanensis*.

30. *Columba corensis* Gmel. TORCAZA.—Common, frequenting the royal palm trees, the berries of which seemed to constitute its sole food. One individual had no less than eighty of these berries, each measuring three-eighths by one-half of an inch in diameter, in its crop. The Torcaza is thus an active agent in distributing the seeds of palm trees. The call of the Torcaza is a vigorous *too-whdo, coo, too-whdo, coo*, with the accent strongly pronounced.

31. *Columba leucocephala* Linn. TORCAZA CABEZA BLANCA. WHITE-CROWNED PIGEON.—Single birds were observed on two occasions.

32. *Zenaidura macroura* (Linn.). PALOMA. MOURNING DOVE.—Everywhere a common species. At San Pablo they were exceedingly abundant, and there were few intervals during the day when their call could not be heard. In the afternoon in walking over the weed-grown bottom of a former course of the Agabama River, at nearly every step this species and the Ground Dove arose in small flocks from almost beneath my feet. They evidently came here to procure the fine gravel which had been brought by the river.

At the time of my visit the birds were breeding, placing their nests in the guava bushes, or even in the palm trees, where the leaves branch out from the trunk. I now frequently observed a peculiar aerial evolution which probably is confined to the breeding season. I have previously observed it only at Corpus Christi, Texas, where also the birds were breeding. This evolution consists of a short, unnatural flight, followed by a sail, which is sometimes over a circular course. This may be repeated two or three times, and the bird then sails to the ground or a near-by perch. The whole performance does not cover over two hundred feet, and is presumably confined to the vicinity of the nest. At least on several occasions I observed it directly above a nest. During this flight and sail the bird so exactly resembles an *Accipiter* that I never saw one engaged in it without involuntarily grasping my gun to shoot what I had mistaken for a Hawk. Indeed, so close is the resemblance, it is only after careful scrutiny that one recognizes the Dove.

Cuban specimens are smaller than examples of *Z. macroura* from the eastern United States, and in their slightly darker color and disproportionately shorter tail, they show an approach to *Zenaida zenaida*. Average measurements are as follows: five Cuban specimens, wing, 5.52; tail, 4.81 in. Five specimens from the vicinity of New York City, wing, 5.92; tail, 5.40 in.

33. *Zenaida zenaida* (Bonap.). GUANARO. ZENAIIDA DOVE.—Common. It is more of a ground Dove than *Zenaidura*, and is therefore less frequently seen. Its notes resemble those of *Zenaidura*, but are deeper, louder and more solemn.

34. *Columbigallina passerina*, subsp. TOJOSITA. GROUND DOVE.—Common.

Throughout its range this small Dove presents much variation in the color of the bill, and to a less extent in the color of the plumage. It is not always possible to determine from dried specimens what was the color of the bill in life, and as few specimens are labeled with regard to this point much of the existing material is misleading. So far as I am aware, in eastern North America and the West Indies, the bill assumes three styles of coloration, as follows: In eastern North America it has the basal half or two-thirds coral red, the tip black or blackish. (In dried specimens the red becomes orange or yellow, and is then indistinguishable from the next.) In Jamaica (*cf.* Scott, Auk, IX, 1892, p. 124) it has the basal half or two-thirds yellow. Mr. Scott informs me that his remarks, as above referred to, are based on fresh specimens. In the Bahamas, according to Mr. Maynard, the bill is "constantly and wholly black." This is one of the characters on which he establishes his *Chamaepelia bahamensis* (*cf.* Am. Ex. and Mart., III, 1887, p. 33).

Cuban birds have the bill in life brownish black, darker at the tip, and with a faint reddish cast basally. The general appearance is that of a black bill, but as I have been unable to make an extended comparison of the Cuban and the Bahaman birds I cannot affirm their identity.

The bird from eastern North America, as before remarked, differs from true *passerina* of Jamaica in having the base of the bill red instead of yellow; there are also differences in coloration.

Mr. Scott has permitted me to examine his fine series of some forty Jamaican specimens, and comparison of these with some twenty examples from Florida shows that they may be separated into two well-marked races. Jamaican males are slightly paler and have whiter throats than Florida males. In the females the difference is more marked, Jamaican birds having the throat whiter, the breast more finely squamate, and the abdomen whiter, and they lack the pinkish tinge seen in Florida specimens. In size the sexes are alike, and, as might be expected, Jamaican birds are somewhat smaller. Five males and five females from Jamaica measure: wing, 3.25; tail, 2.06; bill, .44 in. An equal number of both sexes from Florida measure: wing, 3.50; tail, 2.30; bill, .44 in. It is evident then that the name *passerina* can no longer be accepted for the bird from eastern North America. In describing his *bahamensis* Mr. Maynard remarks (l. c.): "'Tis only after considerable hesitation that I name these species even provisionally; 'tis also possible that Linnaeus [*sic*] of *Columba passerina* was based on specimens of this species and not on birds of the continent of North America. In event of this proving the case, I propose the name of *Chamaepelia purpurea* for the larger continental Dove." It seems to me, however, that this name is unavailable from either logical or zoological grounds. The "event" which Mr. Maynard specifies has not 'proved to be the case,' nor does he designate which of the North American races of *Columbigallina* he proposes to call *purpurea*. Very probably he intended to name the race from eastern North America, but his remarks are so vaguely worded as to be capable of several interpretations. Furthermore, Mr. Maynard did not know the true *passerina*, and he thus fails to mention the differences which serve to distinguish the eastern North American bird from the bird which Linnæus named. In view of the unsatisfactory basis on which the name *purpurea* stands it seems unwise to recognize it, and I suggest, therefore, that the Ground Dove of eastern North America be known as *Columbigallina passerina terrestris*.

35. *Geotrygon montana* (Linn.). BOYERO. RUDDY QUAIL-DOVE.—A few were observed and several collected beneath the cupey trees at San Pablo. They were feeding on the fallen fruit

of this tree. Their flight is noiseless, and on being flushed they fly for but a short distance and then alight on the ground or in the low undergrowth. Their flesh is more delicate than that of any bird I have ever eaten.

Starnaenas cyanocephalus was reported to me, under the name Perdiz, as being a rare inhabitant of the mountains. I did not meet with it.

36. *Cathartes aura* (Linn.). AURA. TURKEY VULTURE.—Abundant.

37. *Circus hudsonius* (Linn.). GAVILAN. MARSH HAWK.—Four were observed near San Pablo.

On six occasions I observed individuals of an *Accipiter*, but secured no specimens.

38. *Buteo borealis calurus* (Cass.). GAVILAN. WESTERN RED-TAIL.—Red-tailed Hawks were not uncommon, but I secured only one specimen (No. 57,400), an adult male. Comparison with a large series of both *borealis* and *calurus* shows that the relationships of this specimen are with the latter rather than the former. The chin and upper throat are white, but the sides of the neck, breast, and abdomen are heavily marked with deep rufous or black, as in some specimens of *calurus*. The tail has a broad black subterminal band, and all the rectrices have traces, more or less distinct, of black bars. This Hawk, according to Gundlach, is resident in Cuba, and it is not improbable that further material will show it to be an insular race. The specimen just described measures: wing, 15.00; tail, 9.50; tarsus, 3.00 in.

39. *Falco sparverii* (Vig.). CERNICALO. CUBAN SPARROW HAWK.—Common. With few exceptions all the Sparrow Hawks I saw were mated and preparing to breed, and at Guanayara one pair was nesting in a hole in a palm tree. Of fourteen specimens secured nine are of the light and five of the dark phase of plumage. Most of these specimens were taken in pairs, and in every case dark birds had dark mates and white birds white ones. In addition to these specimens a number of pairs were satisfactorily identified, but on no occasion were the two phases seen

together. The calls of both phases are alike, and resemble that of *Falco sparverius*.

In his forthcoming 'Catalogue of West Indian Birds,' advance sheets of which I have just (November 25) been permitted to see, Mr. Cory gives reasons for considering the San Domingo bird separable from the Cuban bird, basing his conclusion on the comparison of forty-six specimens from the former island and twenty-five from the latter. The name *dominicensis*, provided this determination proves correct, should therefore be restricted to the San Domingo bird, which apparently has but one, the light, color phase.

The Cuban bird should therefore stand as *sparnerioides*, and the real point at issue is the identity or distinctness of the two very different color phases which the Sparrow Hawk assumes in Cuba.

It has been shown that the two phases intergrade; it is equally certain, I believe, that they breed together, and Mr. Cory states (l. c., p. 140) that he is informed that "birds of both colors have been taken from the same nest." The question is then whether this is an instance of dichromatism or hybridism. If the former it is certainly one of the most exceptional cases of which we have any knowledge. *Falco sparverius* and its several closely-allied forms range throughout the greater part of North and South America, and are found in nearly every island of the West Indies. At no point in this extended habitat does it give any indication of developing two color phases except in the island of Cuba. The differences which distinguish the two color phases are not such as occur in pure dichromatism, but involve also a change in the pattern of coloration. In the light phase the adult male has the underparts, including the lining of the wing, nearly pure white, while the back is cinnamon, as in *sparverius*. In the full development of the dark phase the underparts, except the throat, are deep cinnamon; *the lining of the wings is heavily barred with blackish*; the back is blue and of the same color as the head, but with traces of cinnamon on some of the feathers. In addition to these changes there is a deepening in the coloration of the other parts. Great as are the differences which exist between these phases they are not greater than those which we

know occur among HAWKS; but the case becomes more remarkable when we consider that so radical a variation in coloration occurs in only one small part of the habitat of the species.

40. *Polyborus cheriway* (Jacq.). CARAIRA. AUDUBON'S CARACARA.—Three individuals were observed and one secured at San Pablo.

41. *Pandion haliaëtus carolinensis* (Gmel.). "GUINCHO." AMERICAN OSPREY.—One observed at Casilda.

42. *Strix pratincola furcata* (Temm.). LECHUZA. CUBAN BARN OWL.—Common. Their wild, startling cry was frequently heard at night, and would be followed by a high, rapidly repeated *cr-r-ree, cr-r-ree, cr-r-ree*, as they flew about in search of food. They live in the caves, evidently choosing such as are inhabited by bats, on which they feed. They also eat mice (*Mus musculus*) and rats (*Mus tectorum*). In the stomach of a specimen shot at noon in a bat-cave were the partially digested remains of three mice and two bats of a species (*Phyllonycteris poeyi*) which measured twelve inches in expanse of wing.

43. *Glaucidium siju* (D'Orb.). SIJU. CUBAN PYGMY OWL.—A common and apparently entirely diurnal species. Their usual note, a softly whistled *coo*, is one of the characteristic sounds of Cuban woods, and may be heard at all hours of the day. Their favorite perch when calling is near the top of a tall leafless tree, and I have seen them in this exposed position facing the sun. The short *coo* is uttered at intervals of about five seconds, and may be continued for more than an hour at a time. It is accompanied by a nervous, vertical twitching of the tail, which is sometimes raised to form an acute angle with the back. A second vocal performance, but a less common one, seemed to be the result of excitement and may be confined to the nesting season. It consists of a series of short whistles, rising in tone, uttered with increasing rapidity, and ending in a high piercing note. Their food seemed to consist of insects, small tree-toads and lizards.

On one occasion I heard a male of this species calling in a grove of cocoa-nuts. He was found without difficulty, and

on approaching I discovered also the female. The male was uttering the *coo*-note and occasionally varying it with the performance just described. To this the female responded with a thin, shrill squeak. As the male was secured the female flew into the top of a dead palm trunk about twenty-five feet in height. A rap at the base of the tree caused her to fly out and she also was secured. She contained an egg ready for deposition. The palm tree was badly decayed and was pushed to the ground. A depression in its top, of about six inches in depth, was evidently the Owl's nest. It was composed simply of the dead palm fibres. In these loose fibres, immediately below and for a distance of about eight feet down, I found twenty-five tree-toads of two species and a 'chameleon.' Some of the toads had bodies three inches long, while the lizard was twelve inches long. As it was more than probable that both had entered this retreat from above, it is natural to suppose they would leave in the same way. But their passage would so evidently interfere with the domestic arrangements of *Glaucidium*, I came to the conclusion that they were in winter quarters and that quite unsuspectingly the Owl had selected a nesting place above them.

A series of fifteen specimens shows that, irrespective of sex, there are two quite different color-phases, a gray and a red, between which there is a complete intergradation. In the red phase the spots or marks on the upperparts are reduced to the minimum, while in the gray phase they are longer and more clearly marked. Sexual variation is shown by the larger size of the females, as follows: six females average, wing, 3.81; tail, 2.43 in.; nine males average, wing, 3.61; tail, 2.30 in.

44. *Amazona leucocephala* (Linn.). COTICA. CUBAN PARROT.—Found only at San Pablo, where they were not uncommon in small flocks of not more than six individuals. They were frequently found feeding on the fruit of the guava, and were also attracted to the mango trees, the fruit of which was just ripening, and which, during its season, constitutes their favorite food. They are restless birds, spending little time in one place. They fly with a strong, rapid wing-beat, which suggests the flight of a cormorant.

45. *Conurus euops* (Wagl.). PERIQUITO. CUBAN PAROQUET.—Common, both at San Juan and San Pablo. They were generally seen in flocks of from ten to twenty, and, like the preceding species, they were restless and much on the wing. Their favorite food seemed to be the berries of the royal palm. They call in chorus while flying and the note is a grating squeak, quite different from the Woodpecker-like *kr-r-r* of *Conurus carolinensis*. Both these species and the Cotica, defer their breeding season until late April and early May, when an abundance of ripe fruit assures them of a food-supply for the young.

In a series of sixteen specimens, thirteen have the plumage more or less mottled with red. There is some regularity, however, in the distribution of this color. On the upperparts it is confined to the head and nape. All but one of these specimens have red feathers also on the sides of the head and neck, and all but two have a few red feathers scattered through the plumage of the underparts.

46. *Saurothera merlini* (D'Orb.). ARRIERO. CUBAN CUCKOO.—A very common species, living in low growths of bushes more or less dense. Its notes are among the most striking of those of Cuban birds. There is apparently no limit to its vocal ability in certain directions, but its ordinary call commences like the rolling squawk uttered by an old, contented hen on a warm day, and increases in volume and rapidity until the notes are joined. This may be heard at a distance of half a mile. A second call is a *cluck*, followed by a gasping note, which would lead one to suppose the bird was being choked to death. This seems to be the result of revery, and when producing it the bird sits in a pensive attitude with the head drawn down between the shoulders, raising it, however, to call. Its other notes or squawks are varied, and on different occasions, after shooting one bird, a survivor has closely approached and scolded me with more weird and horrible sounds than one can well imagine issuing from the throat of a bird. Their food was found to consist of beetles and lizards. In the stomach of one specimen I found the partially-digested remains of an *Anolis* measuring one and a half inches across the angle of the jaws. The stomach was distended to the utmost and measured seven by five inches in circumference.

While it was not unusual to see this bird on the ground, it is by no means a Road-runner; still, in its habit of mounting a bush or tree by jumping from branch to branch, and then reaching the ground by sailing, it reminded me strongly of *Geococcyx*. It is not shy, and will permit one to approach to within a few yards before hopping or moving by short flights through the bushes, or mounting a tree in the manner described.

47. *Crotophaga ani* (Linn.). JUDIO. ANI.—Common in flocks of from five to twenty individuals. They pass much of their time on the ground and are generally found near herds of cows or hogs. On being alarmed they fly into the nearest bushes or low trees, uttering at the same time a kind of long-drawn complaining whistle, suggestive of the note of the Wood Duck. Perched there, with plumage hanging loose and bedraggled, calling their whining cry, they appear as dispirited and cringing as a whipped cur. Their infrequent long flights are accomplished by alternate flapping and sailing. They roost in the low bushes and crowd so closely together that a roosting flock resembles a bunch of black feathers.

48. *Priotelus temnurus* (Temm.). TOCORORO. CUBAN TROGON.—This beautiful Trogon haunts the more secluded parts of the woods, where it is common and generally found in pairs. It is, as a rule, exceedingly tame and will permit one to approach to within a few feet. Its flight is short, generally from tree to tree, and it passes much of its time resting quietly. The call of the male is a rather melancholy *kr-r-row*, *kr-r-row*, *kr-r-row*, and this note is sometimes muttered while on the wing. To this the female responds with a much lower but somewhat similar note. Perched on the branches of the same tree, or even when out of sight of each other, a pair will thus call for long periods, one answering the other with the greatest regularity.

Their food consists of insects and berries. I have seen them dart at flowers, probably to get the insects in or near the blossom. Berries were taken in the same way, that is, by darting and picking them from the stem on which they were growing. At the moment the fruit was secured the position of the bird was nearly upright, the wings of course were moving, the tail was

spread to the utmost, and with its brilliant plumage thus displayed *Priotelus* made a striking picture of tropical bird-life.

49. *Ceryle alcyon* (Linn.). "MARTIN PESCADOR." BELTED KINGFISHER.—Not uncommon.

50. *Todus multicolor* Gould. PODORERA. CUBAN TODY.—Among the most interesting of West Indian birds are the members of the family Todidæ, the only family of birds peculiar to these islands. Although so unlike them in color and general appearance, they still bear a laughable resemblance to their distant but nearest relatives the Kingfishers. Indeed, a Tody might be described as a green-backed, red-throated Kingfisher less than four inches in length, with a bill and habits resembling those of a Flycatcher.

Although a common species, the Podorera does not take a prominent place in the Cuban avifauna. Its haunts, habits and green color tend to make it an inconspicuous bird. As a rule I found them in pairs, frequenting low bushes in the woods or sometimes among the guavas. Their notes very closely resemble the sharp chittering of the Ruby-throated Hummingbird. When at rest their position is rather upright, the axis of the body being at an angle of about fifty degrees. At this time they frequently raise their head with a curious bobbing movement. All their food is apparently captured on the wing, after the manner of Flycatchers, but they differ from Flycatchers in that they generally seek a new perch after darting for their prey, and also that this perch is more likely to be in the centre of a bush than in the more exposed position a true Flycatcher would select. When they alight with their back to the observer its color harmonizes so well with that of the surrounding foliage that it is difficult to distinguish them. I did not observe, however, that the bird seemed aware of this protective resemblance. Perhaps the most peculiar characteristic of this little bird is the singular wooden whirring sound which sometimes accompanies its flight. After close observation I am convinced that this sound is produced by the attenuate primary found in the wing of both sexes. My reasons for this belief are: (1) that I heard the sound only when the bird flew with more than usual swiftness; (2) the sound corre-

sponded with the short undulations in the bird's flight from bush to bush. Furthermore, neither Gosse (Bds. Jamaica, p. 72), Scott (Auk, IX, 1892, p. 274), nor Taylor (*ibid.*, p. 373) mention this whirring sound in their accounts of the Jamaican species, and on examination I find that in that species the outer quill is shorter and not so attenuate, curved, or stiffened as in the Cuban bird.

51. *Sphyrapicus varius* (Linn.). YELLOW-BELLIED SAP-SUCKER.—Observed on two occasions.

52. *Xiphidiopicus percussus* (Temm.). CARPINTERO REAL. GREEN WOODPECKER.—Common. Though not a 'Sapsucker,' this bird reminds me, in its habits and notes, of the preceding species.

53. *Centurus superciliaris* (Temm.). CARPINTERO JABADO.—A very common and noisy species. Its notes resemble those of the Red-bellied Woodpecker, but are louder, and I did not hear the Cuban bird utter the hoarse *chüh, chüh*, of *Centurus carolinus*.

54. *Colaptes chrysocaulosus* Gundl CARPINTERO RIBERO. CUBAN GOLDEN-WINGED WOODPECKER.—Not uncommon. Resembles *Colaptes auratus* in its habits and notes.

55. *Antrostomus carolinensis* (Gmel.). GUABAIRO. CHUCK-WILL'S-WIDOW.—One was collected at San Pablo.

56. *Chordeiles*, sp?—Nighthawks were first observed on April 13, when they commenced to arrive from the South. I did not secure specimens, and cannot therefore say to which race they belong, though it is probable they were *Chordeiles virginianus minor*.

57. *Cypseloides niger* (Gmel.). GOLONDRINA. BLACK SWIFT.—Probably a common species. Flocks of large Swifts were seen almost every evening at San Juan, but at such an enormous height that on only one occasion did I observe an individual near enough to identify it with certainty.

58. *Hemiprocne zonaris* (Shaw). GOLONDRINA. COLLARED SWIFT.—A bird of this species flew low over my head near San Pablo. At no other time did I recognize it, though, as before stated, at San Juan large Swifts were frequently seen in the evening at an immense height.

59. *Tachornis phœnicobia* Gosse. GOLONDRINA.—This little Swift was common only at San Pablo, and was not seen at either Guanayara or in the mountains. They appeared late each afternoon, coursing rapidly for food, and in their manner of flight somewhat resembled a Bank Swallow.

60. *Sporadinus ricordi* (Gerv.). ZUMBADOR. RICORD'S HUMMINGBIRD.—Common. A nest containing two eggs, found March 11, was placed on the swaying branch of a coffee bush. It was composed of green moss, bound about with strips of bark, which hung in flowing streamers five inches below.

61. *Tyrannus magnirostris* D'Orb. "PITIRRE REAL." LARGE-BILLED KINGBIRD.—Four individuals, the only ones observed, were secured at San Pablo.

62. *Tyrannus dominicensis* (Gmel.). PITIRRE. GRAY KINGBIRD.—This is one of the few birds which are found in Cuba during the summer only. They were first seen on March 19, soon became common, and in April were abundant. At this time they commenced to mate and their noisy chattering cry of *pit-tirri, pitirri*, from which they receive their local name, was one of the commonest bird-notes.

63. *Pitangus caudifasciatus* (D'Orb.). GUATIBERO.—This Flycatcher very closely resembles the Kingbird (*Tyrannus tyrannus*) both in appearance and habits. Its notes, however, are quite different. When excited or in pursuit of another bird it has a cry like that of a nest full of hungry young birds, and when resting it gives utterance to a long rolling *chitter*. In April they commenced to mate and were then particularly noisy, calling long after nightfall. The Jamaican *Pitangus* has been referred by previous writers to the Cuban *P. caudifasciatus*; it is, however, apparently separable, and may stand as

***Pitangus jamaicensis*, sp. nov.**

Char. Sp.—Differing from the Porto Rican *Pitangus taylori*, and the Haytian *P. gabbi*, in being slightly lighter and in having a broad basal and a narrow terminal whitish tail-band; differing from the Cuban *P. caudifasciatus* in being darker and in having the crest bright lemon yellow instead of orange.

Description of type. (No. 42,647, Coll. Am. Mus. Nat. Hist., adult male, Moneague, Jamaica, February, 1865. Collected by Henry Bryant. Collector's No. 2227.)—Head dark brownish black with a partly concealed crest of bright lemon yellow and not sharply defined from the hair-brown back; wings of the same color as the back, the outer margins of the coverts and tertials whitish, the axillaries and lining of the wing pale yellow; tail of same color as the head, the inner margins of the feathers whitish for their basal third; outer vanes of the lateral feathers whitish and a narrow terminal whitish band; underparts white. The female is similar to the male.

Comparison of five Jamaican specimens with nineteen specimens from Cuba show the characters assigned the new form to be constant so far as this material goes.¹

64. *Myiarchus sagræ* (Gundl.). BOBITO.—Not uncommon. It resembles a *Contopus* in habits, and its call has the same plaintive quality as has the note of *Contopus virens*.

65. *Blacicus caribæus* (D'Orb.). BOBITO.—Very common. It resembles the Wood Pewee in habits but lives nearer the ground. Its notes also are suggestive of those of *Contopus virens*. A nearly completed nest, found April 9, was placed in a fork of an outer branch of a guasima tree about fifteen feet from the ground. It was constructed of grasses, small twigs and plant-down.

66. *Corvus nasicus* Temm. CAO.—Found only at San Pablo, where they were not uncommon in the woods and were feeding on the fruit of the cupey tree. Their call is a high, penny trumpet-like note, delivered after the manner of a Crow's *caw*, but frequently accompanied by a series of prolonged squawks, the whole performance sounding quite uncrow-like.

67. *Agelaius humeralis* (Vig.). MAYITO.—Abundant. It was found feeding among the blossoms of trees, and in its

¹ Since writing the above I have, through the kindness of Mr W. E. D. Scott, been permitted to examine his fine series of sixty odd specimens of the Jamaican *Pitangus* and they confirm the validity of the species.

habits resembles an *Icterus* rather than an *Agelaius*. It has, however, a Blackbird-like *cack* and a single whistle not unlike that of *Agelaius phoeniceus*. I have also seen it, with drooping wings and spread tail, utter the hissing note of *Molothrus ater*.

68. *Sturnella hippocrepis* Wagl. SABANERO. CUBAN MEADOWLARK.—Found only in the Trinidad Valley, where they were abundant in old fields. No bird I observed in Cuba proved more interesting than this Meadowlark. I first met with it on March 15, when during a ride through the Trinidad Valley I had an excellent opportunity to become familiar with its song and habits. My impression of the bird's song as given in my journal for that day is as follows:

"The vocal organs of *Sturnella* are apparently so modified by climatic influences that although some naturalists have pronounced its various races to be one species, no one, I am sure, would recognize in the song of the Cuban bird any resemblance to that of *Sturnella magna*."

Subsequent familiarity with this peculiar song led me to slightly alter this first opinion. It was subject to great variation, and occasionally I could distinguish some faint resemblance to the song of *S. magna*. I was more frequently reminded, however, of the song of the Dickcissel (*Spiza americana*). After several unsuccessful attempts to express in words the typical song of *Sturnella hippocrepis*, I found the syllables, *whēē-chēwēē*, *chückle-chür*, to be a not unsatisfactory description of it. The first two syllables have a whistled tone, the last two are guttural. The single *peek* note uttered by *magna* when its suspicions have been aroused and it is about to fly, was not heard from the Cuban bird.

A comparison of this humble vocal effort with the lauded melody of the Western Meadowlark (*S. m. neglecta*) presents a remarkable range of variation in song power between birds which are ranked as subspecifically related.

During the ride referred to I also observed in *Sturnella* what appears to be an instance of its appreciation of the value of protective coloration. Many birds were seen perching on the fences by the roadside. With one exception these birds did not permit me to see their breasts, but turned their backs as they

alighted near me or on my too close approach, and then watched me from over their shoulders. The exception may with truth be said to have proved the rule, for in this instance *Sturnella* chose the lesser of two evils, and presented his brilliant yellow breast to me, while the inconspicuous brownish back was turned toward a Marsh Hawk which was coursing over the field on the other side of the fence on which the Meadowlark was resting. Having my attention thus early attracted to this interesting trait I closely watched *Sturnella* during the following two weeks, but on no occasion did it fail to turn its back on me when I had approached to within what it considered an unsafe distance.

Fifteen specimens show both the winter and more worn breeding plumage; seven have the bluish-black bill of breeding birds. Comparison of this series with a large number of Meadowlarks shows unexpectedly that the Cuban birds are far more closely related to *Sturnella neglecta* than to any other form of the genus. Indeed, the differences which distinguish *hippocrepis* from *neglecta* consist largely in the smaller size and darker coloration of the former, but in pattern of coloration there is little difference between the Cuban and Western birds. When we consider that Floridan and Mexican birds very closely resemble each other, and represent the extreme of variation from *neglecta*, it is surprising that the Cuban bird should be more closely related to the latter than to either of the former. The relationship, too, brings into more marked contrast the differences which exist between the songs of the two birds.

69. *Icterus hypomelas* (Bonap.). SOLIBIO. CUBAN ORIOLE.—A common species, reminding me, in its flight and habits, of the Orchard Oriole (*Icterus spurius*). Their food seemed to consist largely of insects, which they obtained from the blossoms of flowering trees and plants, that of the banana being an especial favorite. As a result of this habit their heads and necks were frequently well-dusted with pollen, which showed conspicuously on their black plumage, and in some specimens persists as a permanent stain. Their song is weak but sweet and plaintive, and suggestive of that of a far-away Meadowlark (*Sturnella magna*). The single call-note was so like the metallic flight-note of the

[December, 1892.]

English Sparrow that to one familiar with the haunts and character of the latter bird it was strikingly incongruous.

As in the case of several other Cuban species, these birds were almost always seen in pairs, or, on occasions, two pairs would be seen together. I was soon struck by the fact, to which I noted no exception, that these pairs were composed of birds of the same apparent age, that is adult black and yellow birds were mated with birds in the same plumage, while immature birds had immature mates.

One individual of this species, captured after being slightly winged, won my admiration by his fearless behavior. As I held him perched upon my finger, he divided his time between vigorously biting my hand and singing, thus giving a fine illustration of song as a result of excitement.

In a series of twenty-five specimens twelve are males and thirteen females. Sixteen are in the black and yellow plumage of the adult bird. Seven of these are males and eight females. Beyond a slight difference in size, the males being larger, the sexes are indistinguishable. The remaining nine birds have black throats, and the plumage is more or less mottled with black. They are evidently birds of the previous year, and would require one more year in which to complete their plumage.

70. *Quiscalus gundlachi* Cass. CHICHINGUACO. CUBAN GRACKLE.—An abundant and conspicuous species, giving character to the avifauna more than any other bird. It is not, however, found in the towns, as is the Great-tailed Grackle in Texas. It has an extended vocabulary of whistled notes and indescribable calls, and is very noisy. While these notes were unmistakably Quiscaline, I could detect no exact resemblance to the calls of either *Q. macrourus*, *majoi* or *quiscula*. In vocal ability I should rank the Cuban bird between *macrourus* and *majoi*.

In the males the tail is permanently keeled, that is, is wedge-shaped even when the bird is at rest. In flying it is expanded vertically, and measures from four to five inches in depth at the tip. This gives them a most ludicrous appearance, which is heightened by their fluttering, labored flight. Indeed, when on the wing they resemble miniature flying machines. These birds

were particularly abundant about my home in the San Juan Mountains, where they were attracted by the ripe corn in the clearing of a neighboring mountaineer. They passed the greater part of the day feeding on this dainty, but in the early afternoon, as the shadows came into the valley, they all flew, with much fluttering and calling, into the palms at the border of the clearing. Here they fed on the palm berries, passing from tree to tree up the slope of the mountain, following the fast waning light, until finally the sun set, and they roosted where darkness found them.

71. *Ptiloxena* (gen. nov.) *atroviolaceus* (d'Orb.). TOTI.—Abundant. Though frequently found with *Quiscalus gundlachi*, the birds were brought together through a fondness for the same kind of food, and were not in any other sense associated. Indeed, the bird does not resemble a Grackle in either flight or notes. It has a number of calls, the most common of which reminded me of the *peto, peto*, of the Tufted Titmouse. In April I saw them carrying nesting material into the palm trees.

Different authors have referred this bird to the genera *Quiscalus*, *Scolecophagus* and *Dives*. It is evidently more closely related to the last, in which recent authors place it. It differs from *Dives*, however, in several important structural details. In *Dives* the first primary is equal to the eighth, and the third to sixth are subequal; in *atroviolaceus* the first primary is longer than the sixth, and the second to fifth are subequal. *Dives* has a more rounded tail than the Cuban bird; in the latter the outer tail-feather is but a quarter of an inch shorter than the middle pair, while in the former the outer tail-feather is three-quarters of an inch the shorter. There is also a slight difference in the shape of the bill, which in *atroviolaceus* is shorter, stouter, and with a more convex culmen than in *Dives*. The most striking difference between the two, however, is in the structure of the contour feathers of the fore parts of the body, especially those of the breast.

In *atroviolaceus* the barbicels, while apparently of the normal number, are fasciculate, and, except at its basal third, adhere to the barb. For the terminal half of the feather, therefore, the barbs have no connection with one another, and this gives to the

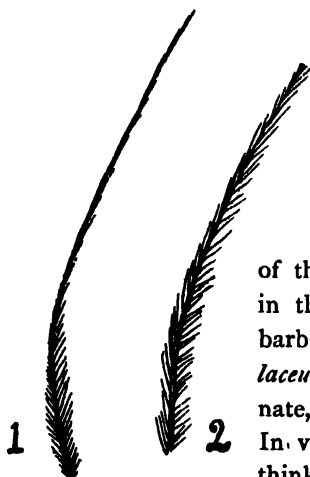


Fig. 1. Barb from a breast feather of *Ptiloxena*. Enlarged.
Fig. 2. Barb of *Dives sumichrasti*. Enlarged.

parts in which these feathers grow a finely streaked, hairy appearance. To some extent this peculiar structure is shown by the West Indian *Quiscalis* of the Subgenus *Holoquiscalus*. In *Dives*, however, and the continental *Quiscalis*, the structure of the feathers is normal, and, as shown in the accompanying cuts representing barbs from the feathers of both *atroviolaceus* and *Dives*, the barbicels are penate, and branch out from the barb. In view of these structural differences I think *atroviolaceus* should be placed in a new genus, for which I propose the name *Ptiloxena*.

72. *Ammodramus savannarum passerinus* (Wils.). GRASSHOPPER SPARROW.—Common at San Pablo, and not uncommon at Guanayara.

Comparison of six specimens of true *savannarum* from Jamaica with a series of *passerinus* from the eastern United States fails to show any constant difference in color which would serve to distinguish these forms. The Jamaican birds average slightly darker, and are without the streakings on the breast found in many North American specimens. In size, however, the Jamaican birds are smaller than United States specimens. Of thirteen specimens from near Trinidad five are without streakings on the breast, but none are as small as the largest Jamaican specimen.

The appended measurements show that they belong to the northern rather than the southern form. Probably they were winter visitants, for Dr. Gundlach says the bird does not breed on the island.

	Wing.	Tail.
Jamaica, six specimens.....	2.24	1.54
Cuba, thirteen "	2.39	1.70
New York, six "	2.42	1.74

73. *Euethia canora* (Gmel.). TOMEGUIN DEL PINAR.—Not uncommon.

74. *Euethia lepida* (Jacq.). TOMEGUIN DE LA TIERRA.—Very common in small flocks, which pass much of their time on the ground. Their song is a not unmusical weak trill.

75. *Passerina cyanea* (Linn.). "AZULEJO." INDIGO BUNTING.—An adult male seen March 18.

76. *Melopyrrha nigra* (Linn.). NEGRITO.—A common species frequenting bushes and undergrowth. They commenced to nest about March 11. With *Euethia canora* this is one of the favorite cage-birds among the natives. Its song, however, is only a weak warble.

77. *Spindalis pretrei* (Less.). CABRERO. CUBAN TANAGER.—Not common. They were generally found in pairs in the woods, and frequented the tops of the trees. Their vocal effort is weak and squeaky and hardly deserves the name of song.

78. *Petrochelidon fulva* (Vieill.). GOLONDRINA. CUBAN CLIFF SWALLOW.—At San Juan a small flock of these birds occasionally came to the river in the morning to drink, and then disappeared. At San Pablo they were common. One morning a flock of about one hundred was seen to leave a large cave on the bank of a river, and after mounting high in the air scattered in various directions. The cave was inaccessible, and I was unable to determine whether it was used for nesting or roosting.

79. *Vireo calidris barbatula* (Cab.). "PREDICADOR." BLACK-WHISKERED VIREO.—A summer resident. First observed March 13, and soon became abundant. It is a very tame and unsuspecting bird, and resembles our Red-eyed Vireo both in song and habits. The song, however, is more emphatic and hesitating than that of *V. olivaceus*.

80. *Vireo gundlachi* Lemb. JUAN CHIVI.—Common. This bird has the habits of a White-eyed Vireo, and its song, while quite unlike that of *noveboracensis* is, nevertheless, of the same character. Its iris is light hazel, another character connecting it with the *noveboracensis-crassirostris* group, of which, in spite of its distinctness, it is probably the Cuban representative.

81. *Arbelorhina cyanea* (Linn.). "APARGEIDO DE SAN DIEGO."—An immature, molting male, taken at San Pablo while feeding on the fruit of the cupey tree, was the only one seen.

82. *Mniotilta varia* (Linn.). BLACK-AND-WHITE WARBLER.
—Not uncommon.

North American Warblers which winter in or migrate through Cuba are not recognized by the natives under specific names, but are known by the general name 'Mariposa.'

83. *Compsothlypis americana* (Linn.). PARULA WARBLER.
—Not uncommon.

84. *Dendroica tigrina* (Gmel.). CAPE MAY WARBLER.—Six were observed.

85. *Dendroica petechia* (Linn.). "CANARIO DE MANGLAR." CUBAN YELLOW WARBLER.—Observed only at Casilda, where a few were found in or near the mangroves. Their song is easily distinguished from that of *Dendroica aestiva*. Three specimens show that in the adult the crown has a cap of reddish chestnut.

Through the kindness of Mr. Ridgway I have been permitted to examine the National Museum specimens of this group, including Baird's types of *Dendroica petechia gundlachi*. These specimens, four in number, are all in immature plumage, and I think misled Prof. Baird to separate the Cuban from the Jamaican bird. I have seen only six specimens from the latter island, and so far as I am able to judge from this material there are no characters on which birds from the two islands may be separated.

The Bahaman bird, however, which has previously been considered the same as the Cuban species, is apparently a quite distinct race and may stand as

***Dendroica petechia flaviceps*, subsp. nov.**

Chars. Subsp.—Smaller and more yellow than any bird in the group, and as a rule without a well-defined crown cap.

Description of Type (No. 39,848, Am. Mus. Nat. Hist. Adult male, Rum Cay, Bahamas, March 4, 1886. Collected by the naturalists of the Fish Commission Steamer 'Albatross.' U. S. Nat. Mus. No. 108,076).—Above greenish yellow, the crown yellower and with traces of concealed rufous; wings

externally brownish black, the quills margined with yellow externally and with their coverts heavily margined externally with the color of the back; tail dark greenish brown, the inner webs of the feathers, except the middle pair, entirely yellow except at the tip and a narrow strip along the vane; underparts rich yellow, the breast and sides streaked with rufous. Wing, 2.38; tail, 1.98; bill, .41 in.

Of this new race I have examined a series of twenty-one adult males from Rum Cay, New Providence, Conception, Watling, Eleuthera and Cat Islands, taken by the same collectors in March, 1886. In nine of the twenty-one the rufous of the head, while not clearly defined, is at once evident; in the remaining twelve the head is apparently but slightly yellower than the back, but on closer examination the feathers are found to have small brownish centres or shaft streaks. The most highly-developed birds of the nine have the brownish centres larger and showing through the greenish yellow tips of the feathers. Doubtless in more worn plumage these yellowish tips would disappear, and in three birds from Conception and Watling Islands there would remain sufficient brown to form a cap similar to that seen in Jamaican and Cuban specimens. The smaller size of the Bahaman bird is shown by the following average measurements: Nine males from Rum Cay: wing, 2.40; tail, 2.01; bill, .40 in. Three males from Cuba: wing, 2.56; tail, 2.07; bill, .40 in. Five males from Jamaica: wing, 2.59; tail, 2.12; bill, .40 in. Two males from Grand Cayman: wing, 2.54; tail, 2.05; bill, .40 in.

86. *Dendroica cærulescens* (Gmel.). BLACK-THROATED BLUE WARBLER.—Both sexes were very common.

87. *Dendroica coronata* (Linn.). MYRTLE WARBLER.—Two were observed.

88. *Dendroica dominica* (Linn.). YELLOW-THROATED WARBLER.—Two were seen, one of which was secured.

89. *Dendroica palmarum* (Gmel.). PALM WARBLER.—Exceedingly common. I saw no specimens of *hypochrysea*, which is easily distinguishable from *palmarum* in the field.

90. *Dendroica discolor* (Vieill.). PRAIRIE WARBLER.—Common.

91. *Seiurus aurocapillus* (Linn.). OVEN-BIRD.—Not uncommon.

92. *Seiurus motacilla* (Vieill.). LOUISIANA WATER-THRUSH.—Not uncommon.

93. *Geothlypis trichas* (Linn.). MARYLAND YELLOW-THROAT.—Not uncommon.

94. *Setophaga ruticilla* (Linn.). AMERICAN REDSTART.—Common.

95. *Mimus polyglottos* (Linn.). SINSONTE. MOCKING-BIRD.—Two birds, one of which was singing, were seen on the south slope of the coast range near Trinidad. They are not common anywhere, and are unknown away from the immediate vicinity of the coast.

96. *Galeoscoptes carolinensis* (Linn.). SINSONTE GATO. CATBIRD.—Common, but not in song.

97. *Polioptila cærulea* (Linn.). "RABUIŦA." BLUE-GRAY GNATCATCHER.—Five were seen, of which two were secured. I have not compared them with *P. c. cæsiogaster*, of which I have no specimens.

98. *Polioptila lembeyi* (Gundl.). "SINSONTILLO."—One specimen was secured at Casilda. It was singing a song which resembled that of *P. cærulea*, but it possessed greater volume and sweetness.

99. *Mimocichla rubripes* (Temm.). ZORZAL. CUBAN ROBIN.—An abundant species, reminding me strongly in some of its habits of our Robin (*Merula migratoria*). It was, however, an inhabitant of the lower growth, but still, like the Robin, it frequented the clearings, hopping a yard or so, then stopping, raising and lowering its tail in a pensive kind of way. At times it flew into the higher branches of the trees to sing. Its song is a weak, unmusical performance, curiously suggestive of a young Robin's first attempts, while the manner of singing is somewhat disconnected, as though the bird sang with an effort. A common and very singular call-note resembled the cry uttered by an

adult Robin when held captive and presumably greatly alarmed or in pain, but *Mimocichla* utters this call when alone and under no excitement whatever.

As a rule these birds were seen in pairs, and though evidently mated they showed no signs of breeding.

There is remarkably little sexual or individual variation among nineteen specimens collected in the mountains and in the valley, and all are typical of *rubripes*. *M. schistacea* is apparently confined to the eastern part of the island but the differences which distinguish it from *rubripes* are so slight that they doubtless intergrade as their habitats approach each other.

II.—NOTES ON MAMMALS OBSERVED.

According to Dr. Gundlach (Cont. Mamalogia Cubana, Havana, 1877), there are found in Cuba three species of *Capromys*, one of *Solenodon*, and nineteen species of Bats.

The Solenodont is apparently unknown near Trinidad. Of Bats, one sees only the insect-feeding species coursing in the open, while the fruit-eating species are confined to the woods. Shortly before leaving San Juan I found that a long, narrow tract of woods at the base of the mountain was the nightly highway of immense numbers of Bats. They rushed through here in a continuous flight, flying from within a few feet of the ground to a height level with the tree tops. They were doubtless of several species, but I did not succeed in finding the cave or caves from which they proceeded.

1. *Mus tectorum* Savi. RATA. ROOF RAT.—Abundant. I found this Rat inhabiting remote caves in the mountains where it was feeding on wild fruits, and was evidently quite independent of man. I saw neither *Mus rattus* nor *M. decumanus*.

2. *Mus musculus* Linn. "RATONCITO." HOUSE MOUSE.—Abundant. In disintegrated Barn Owl pellets, secured in a cave, I found the remains of twenty-five House Mice and one Rat. The absence of the remains of other small Rodents is evidence pointing towards their absence from the island.

3. *Capromys pilorides* Say. HUTIA CONGA.—A common animal in the mountains and foot-hills where it lives among the rocks. It passes the day in concealment, generally in one of the innumerable holes among the rocks, and comes out at night to feed. At the time of my visit it was feeding on the 'guasima,' a small, round, green, nut-like fruit, which grew in abundance in trees about twenty feet in height. It is arboreal, and obtains this fruit by climbing the trees for it. It climbs slowly, but passes along limbs having a diameter of not more than one and a half inches with ease. It sometimes passes the day in a tree, choosing one with a rich growth of parasitic plants among which it conceals itself.

The largest of three specimens is an adult female, which contained four small embryos, and measured: total length, 31.88; tail, 8.07; hind foot, 3.93; fore foot, 2.44; greatest girth, 3.46 in.

The Hutia Mono (*Capromys prehensilis*) was reported to me by the natives, who said it was much rarer than Hutia Conga.

4. *Capromys columbianus*, sp. nov.

Based on a portion of a semi-fossil skull, showing the malar and alveolar portion of the maxillary of the right side, one upper molar, the anterior portion of the palate and anterior two-thirds of the inner border of the molar alveoli of the left side.

This fragment of the skull, of which a figure is presented,¹

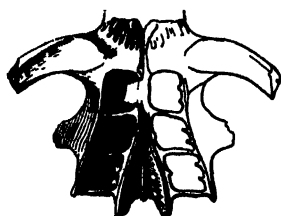


Fig. 3. Portion of the skull of *Capromys columbianus*. Nat. size.

belongs to a species of *Capromys*, slightly smaller than fully adult specimens of *Capromys pilorides*, but differing decidedly from any known species of the group.

In *pilorides* the space between the inner borders of the alveoli at the anterior margin of the upper pre-molar is .21 in.;² in *columbianus* the space between the same parts at the anterior margin of the first molar is but .04 in., and the alveoli would

¹ Compare with a figure of the inferior surface of the skull of *Capromys ingrahami*, this Bulletin, III, 1891, p. 335.

² Cf. also Dobson, P. Z. S., 1884, p. 235, where measurements of the skulls of four species are given.

apparently meet between the premolars. The malar portion of the maxillary is much expanded in *columbianus*, and at its base extends from a point opposite the first internal loop in the exterior margin of the premolar to the maxillo-premaxillary suture, and its inferior face is more deeply sulcate than in that of *pilorides*. The molar is either the first or second of the right upper series. The enamel pattern is somewhat different from that of *pilorides*, but the folds bear the same relationships to one another as do those in the molars of *pilorides*.

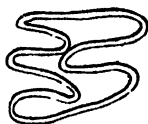


Fig. 4. Right upper molar of *Capromys columbianus*. About three times nat. size.

This portion of the skull was found in a cave near Trinidad, associated with remains of bats and birds, and also fragmentary pieces of the bones of *Capromys* of perhaps the same species as the one described.

The cave is situated in the southern slope of the coral limestone coast range at an altitude of about seven hundred feet, and within two hundred feet of the summit of this part of the range. Imbedded in the conglomerate walls of this cave were numerous shells, some of which I collected and have submitted to Prof. Whitfield, who has identified them with living species. This fact, in connection with its coralline structure, shows the cave to be of recent, doubtless Quaternary, formation.

The floor of the cave was covered to the depth of several feet with a red, ferruginous earth, and on this was a layer four or five inches in depth of a dark earth in which the bones mentioned were found.

The Hutia, as the native West Indians called the various species of *Capromys*, is the first animal mentioned from the New World by Columbus. Being almost the only edible quadruped, it formed an important part of the fare of the early colonists, and on the shores of South Cuba, in the then Province of Ornofai, perhaps within sight of the cave just described, Columbus landed with his crew and was feasted by the natives on the flesh of the Hutia. It seems eminently proper, therefore, to connect his name with the genus.

5. *Vesperugo fuscus cubensis* (Gray).

Scotophilus cubensis GRAY, Ann. Nat. Hist. IV, 1839, p. 7.

Vesperus duteertrous GUNDL. Cont. Mamalogia Cubana, Havana, 1877, p. 32.

Vesperugo serotinus Var. β . (*Vesperus fuscus*) DOBSON, Cat. Chiropt. 1878, p. 193 (Cuban references only).

Vesperugo fuscus J. A. ALLEN, Bull. Am. Mus. Nat. Hist. III, 1890, p. 169 (Bahamas).

The Brown Bat is a common species in Cuba, and with other purely insectivorous species was seen nightly coursing for food. Fourteen individuals found hanging together on the wall of a limestone cave proved to be all females.

These specimens are not smaller than examples of *fuscus* from North America, but, like the specimen described by Dr. Allen from the Bahamas, the ears and wing membranes are thinner than in North American specimens, and the former are slightly narrower and more pointed. These differences appear to be constant, and I think render the Cuban Brown Bat worthy of recognition as a race.

6. *Atalapha noveboracensis pfeifferi* (Gundl.).—Apparently not common. Two intensely colored specimens, both males, were secured. They are of the same size and show that, as has been claimed, the Cuban Red Bat is slightly larger than the North American *noveboracensis*. I do not observe, however, that the premolar is larger in the Cuban form, as has been claimed. The measurements of the two specimens are as follows: forearm, 1.71; third finger, 3.48; tibia, .90 in. North American specimens average: forearm, 1.60; third finger, 3.20; tibia, .87 in.

7. *Nyctinomus brasiliensis* Is. Geoffroy.—Common. Just after sunset, on March 17, thousands of these Bats were seen flying to the westward. On no other occasion were they seen in anything like the same numbers.

8. *Phyllonicterus poeyi* Gundl.—This species was not met with alive, and is included on the basis of two skulls found in the stomach of a Barn Owl.

9. *Artibeus perspicillatus* (Linn.).—Exceedingly abundant. This was found to be the common Cave-bat; indeed, was the only one which I succeeded in finding in numbers.

At San Pablo I visited a cave consisting of a series of chambers opening one into the other or to the surface, which were inhabited by these Bats in countless thousands. On arriving, a few were seen hanging in clusters from the rounded depressions which dotted the roofs of the chambers. It was light here, and on seeing us the Bats took wing, flitting about from cave to cave in search of new resting places. Finally we discovered a nearly dark chamber about seventy-five feet in diameter, and with walls twenty feet in height, with only two small openings. The moment we entered there was a rush of wings, sounding like the wind through trees; we could catch glimpses of many Bats, while a steady stream of them poured from the two openings. Bringing dead palm leaves we used them as torches, and their light revealed a wonderful sight. The white limestone roof of the cave was patched and streaked with hanging Bats, which in lines, bunches and large solid masses covered at least half its surface, while over our heads an incalculable swarm was circling to and fro. They were apparently all adults of one species. The floor of the cave was covered with the remains of fruit, which was mostly of the kind known as 'guasima.' Of fifty-six Bats taken at this cave twenty-four are males, and thirty-two females. Eighteen of the females contained one embryo each. All these Bats were infested by a small parasitic fly and spider.

Taken as a whole this series is quite constant in coloration, but comparison of the extremes shows, nevertheless, a wide range of variation in color. The underparts in the average specimen are light brown, with the hairs all tipped with white. In one extreme the color is much paler, almost grayish white, in the other the underparts are of a darker brown than the average, the hairs scarcely, if at all, tipped with white. There is less variation in the color of the back, which is usually of a light seal brown. The facial streaks are nearly obsolete, and in many specimens entirely wanting. There is apparently little sexual variation in either color or size.

This Bat is, of course, not true *perspicillata* but in the absence of material for comparison, I cannot determine to which of the numerous forms of this group it should be referred.

III.—REMARKS ON THE ORIGIN OF WEST INDIAN BIRD-LIFE.¹

The marked peculiarities exhibited by the fauna of the West Indies have long claimed the attention of zoölogists. The proximity of the group to the mainland, the inter-relationships of the islands, the distinctness of some West Indian species, the evident relationships of others, combine to present problems of unusual interest to the student of island-life. At the same time the physical changes to which the islands have been subjected, their past probable connection with one another and with the mainland, render a study of the origin of their life far more complicated than in the case of purely oceanic islands.

In 1876, when Wallace wrote on the West Indian fauna (*Distribution of Animals*), he presented a table of 203 species of resident land-birds which had been recorded from this region. Since that date, largely through the efforts of Mr. C. B. Cory, Mr. Lawrence's reports on Ober's collections, and Mr. Ridgway's reports on material collected by the naturalists of the Fish Commission, our knowledge of the West Indian avifauna has been so augmented that the known number of resident land-birds is now considerably over 300. In addition to this increase in our knowledge of the avifauna we have, through the cruises made by vessels of the Fish Commission, more accurate and detailed information regarding the topography of the Caribbean basin. This has been well summarized by Prof. A. Agassiz in his 'Three Cruises of the Blake.' With the added assistance derived from these later works we may briefly review the bird and mammal life of the West Indies with particular reference to its bearing on a past connection of the islands with the Central American mainland.

Some 550 species and subspecies of birds have now been recorded from the West Indies. Of these no less than 303 are endemic, while the remaining 248 may be allotted according to

¹ Read before the American Ornithologists' Union, Tenth Congress, Washington D. C., Nov. 15-17, 1892.

the regions from which they apparently have been derived, as follows:

Continental.....	16
Tropical	56
South American....	13
Central American..	3
North American.....	160

The first, or Continental, includes species of more or less general distribution throughout both North and South America. Five are land-birds and eleven water-birds. The second, or Tropical, includes species of general distribution in the tropics. Many of these reach the southern border of the United States, and some are found throughout the Tropical Realm. Eighteen are land-birds and thirty-eight water-birds. Of the third, or South American group, ten, all of which are land-birds, are found in only the Windward Islands, while the three which occur in the Greater Antilles are water-birds. Of the three Central American or Mexican species, one is a Swift (*Cypseloides niger*), one a Duck (*Dendrocygna autumnalis*), and the third (*Icterus cucullatus*) has been recorded only from Cuba, where it has been found but once. The fifth, or North American group, consists of birds which pass the nesting season in North America and, with few exceptions, occur in the West Indies only during the winter or while on their migrations. Eighty-nine are land-birds and seventy water-birds. As Prof. Baird has shown,¹ they are all birds of eastern North America which enter the West Indies through Florida. Cuba, therefore, receives by far the larger share. While a study of this later and migratory life will, in some instances, show us the sources from which the more recent West Indian species have been derived, it will not aid in determining the origin of the more distinct species which may have become West Indian under physiographic conditions not now prevailing. It is only by a study of the endemic species that we may hope to gain some understanding of the past history of the islands. As already stated, 302 species are endemic. Some of these reach the neighboring mainlands, as, for example, southern

¹ Am. Journ. Sci. and Arts, XLI, 1866, p. 18.

Florida; but they are none the less truly West Indian. Of the number mentioned only nine are water-birds. This leaves 293 land-birds as peculiar, or about 90 per cent. of the resident land-bird life. Considering how near the islands are to the mainland this is certainly a remarkable degree of specialization.

The Relationships of the Greater to the Lesser Antilles.—The more distinct and characteristic West Indian species are found in the Greater Antilles. While in some instances, *e. g.*, *Myiadestes* and *Quiscalus*, certain West Indian forms are developed in both the Greater and Lesser Antilles, it is evident that the zoölogical relationships between the two regions are comparatively recent and, as Wallace has said, they may be divided into "two very different groups" (Distrib. Animals, Am. Ed., II., p. 62). Wallace, however, drew his dividing line "immediately south of St. Croix and St. Bartholomew," thus placing these islands, with St. Martin, Anguilla and Sombrero, in the Greater Antilles. But, as Prof. Agassiz has shown (Three Cruises of the Blake, II, p. 112), with the exception of St. Croix, these islands are enclosed by the 500-fathom line which, except for the more eastward Barbadoes and a narrow channel north and south of Martinique, unites the chain of Windward Islands with South America. To the westward the Anguilla group is separated from the Virgin Islands by the Anegada Channel, having a depth of from 1000 to 1600 fathoms. The position of St. Croix cannot perhaps be definitely determined. Its faunal affinities are with Porto Rico, to which it is connected by "a submarine ridge with a depth of about 900 fathoms" (Agassiz, l. c.), while to the eastward it is separated from the Saba Bank by a ridge having a not greater depth than 800 fathoms. Cleve (Annals N. Y. Lyceum, 1881, p. 189) states that St. Croix belongs geologically to the Virgin Islands, and remarks: "The large West Indian Islands contain, then, ridges of raised Cretaceous rocks and the Virgin Islands form their eastern outcrops. South of the Virgin Islands they are not met with except in Trinidad." Thus Anguilla, which, according to the same author, is entirely of Miocene formation, is placed with the Lesser Antilles. Its position is of importance, for from the bone caves of this island Cope has described the

only fossil mammalia which, so far as I am aware, have been found in the West Indies (excepting the *Capromys* described in the present paper). These remains, consisting of detached teeth and fragmentary bones, are considered as related to the South American Chinchillas.

It is evident then that, as Prof. Agassiz remarks (l. c., p. 113, footnote), "the Windward Islands were probably raised long after the range of the greater West Indian Islands existed...." In analyzing their avifauna, therefore, I shall treat of the two as separate regions. As might be expected, there has been an interchange of life between these two groups; certain Lesser Antillean genera, *e. g.*, *Margarops* and *Bellona*, extend northward into the more eastern Greater Antilles, and the larger islands have in some instances contributed to the life of the smaller, as in the case of a species of *Mimocichla* found in Dominica. Again, some genera have a continuous range from South America through the Antilles to Central America. But it is evident that the zoölogical influence of the Lesser on the Greater Antilles is of comparatively late date, and has no primary bearing on the origin of the older forms which characterize the last-named group.

Our inquiry lies more with the older islands, but before treating of them we may briefly review the avifauna of the Windward group.

The Lesser Antilles.—About 108 resident land-birds are known from the Lesser Antilles. Of these thirteen are South American, of which ten are West Indian only as they occur in the Lesser Antilles, and fourteen are West Indian species which have a continuous West Indian distribution. This leaves us with eighty-one land-birds as peculiar to the group. *Fulica caribæa*, the only peculiar water-bird, doubtless has a wider range than we are at present aware of. Eight genera are peculiar. Two of these, *Margarops* and *Bellona*, send each a species into the eastern Greater Antilles, but they are none the less distinctively Lesser Antillean. Excluding the two species just referred to, these eight genera contain seventeen species. Subtracting these from the eighty-one endemic land-birds we have left sixty-four
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species. These may be divided, according to their relationships, as follows :

Tropical.....	22
South American. . ,	19
West Indian.....	23

The first includes localized forms of wide-ranging tropical species; the second is composed of species obviously derived from South American ancestors, *e. g.*, *Merula*, *Thryothorus*, *Calliste* and *Saltator*. The third contains species belonging to groups or genera which are now West Indian, though it is not improbable that some of them may originally have been derived from South America through the Lesser Antilles.

A comparison of the fauna of Trinidad, Tobago and Grenada, the most southern of the Antillean chain, will show more clearly the nature of the South American element in the Lesser Antilles. Omitting migrants and species of general distribution, some 150 land-birds are given from Trinidad by Léotaud. Of these about fifty-four are recorded by Jardine¹ from Tobago, which is distant twenty miles from Trinidad. With the exception of the very slightly differentiated *Troglodytes tobagensis* and the doubtfully distinct *Amazilia tobaci*, Tobago has no species not found in Trinidad, while the fifty-four species mentioned include representatives of such local and non-migratory families as Pipridæ, Momotidæ, Galbulidæ, Dendrocolaptidæ and Formicariidæ, thus strongly indicating a previous land connection with Trinidad.

From Wells's list of Grenada birds² we learn that of the 150 Trinidad species of which, as just stated, fifty-four reach Tobago, only fifteen appear or are represented by close allies in Grenada. None of the sedentary families mentioned as occurring in Trinidad and Tobago are found in Grenada, and with the exception of one species each of *Thryothorus*, *Calliste*, *Saltator* and *Spermophila*, the genera of Grenada have a more or less extended West Indian range. On the other hand Grenada has eight species not found in Trinidad. Grenada is seventy-five miles

¹ Ann. and Mag. Nat. Hist., XVIII, 1846, p. 114, et seq.

² Proc. U. S. Nat. Mus., 1886, p. 609.

from Trinidad, and the difference which we have seen to exist in their avifauna is such as might under the present conditions be expected. It would seem, therefore, that since the appearance of the present fauna no connection has existed between this island and the mainland. If we except the fossil remains found on Anguilla, and the possibly unassisted presence of a now apparently distinct Agouti (*Dasyprocta cristata*), this view is supported by the absence of terrestrial mammalia, excluding those whose introduction is due to man's agency.

The Greater Antilles.—In a previous paper (Am. Nat., 1891, pp. 528–539) I have given reasons for believing that the Bahamas are zoölogical dependencies of the surrounding mainland and islands, from which their avifauna has been derived.

Grand Cayman, with its fifteen peculiar forms, showing relationships largely to Cuban and also to Jamaican species, may perhaps be placed in the same category. This island is situated about 175 miles from Cuba, and 200 miles from Jamaica. It is enclosed by the 1000-fathom line, this depth being reached within a few miles of the shore, while to the north and west it is separated from Cuba and the mainland by 1500 to 2000 fathoms. On the south it is separated from Jamaica by the Bartlett Deep, which has a depth of over 3000 fathoms only twenty miles south of Cayman.

Dr. Sclater has said (Ibis, 1887, p. 125), "Probably the Caymans were mainly stocked with life not by immigration, but when still part of the old Continent out of which the Antilles were carved by the Gulf Stream;" but there is apparently little ground for this belief.

Little Cayman and Cayman Brac, smaller islands, sixty-five miles east of Grand Cayman, from which they are separated by a channel of 1000 fathoms, have, as Mr. Cory has shown (Auk, 1889, p. 30), an avifauna which "is apparently quite different from that of Grand Cayman." They have no peculiar species, and "only five of the resident species of Grand Cayman appear to be found on either of the smaller islands" (Cory, l. c.). Commander Bartlett has remarked of Little Cayman, Grand Cayman, and the Misteriosa Banks to the westward, that they are "the

summits, just appearing above tide-mark, of a submarine range of an average height of nearly 20,000 feet" (Three Cruises of the Blake, I, p. 100). We may then regard them as mountain peaks which at different periods have been elevated above the sea. Grand Cayman, with its remarkable number of peculiar forms, is doubtless the oldest, that is, was the first to appear. Little Cayman, with no endemic species, and the Misteriosa Banks probably followed in the order named.

Is it possible that Grand Cayman may once have been connected with Cuba in the direction of the shoal that makes out from Cape Cruz to the westward, but the difference which exists between its avifauna and that of the small Caymans does not confirm this supposition. When we consider also that the avifauna of Grand Cayman is composed of birds having the power of extended flight, and that such abundant but more sedentary Cuban species as *Todus*, *Saurothera* and *Priotelus* are wanting, we may, I think, with some assurance, class it as an oceanic island which has received its bird-life through migration from other islands.

This leaves us with the four islands of the greater Antilles, Jamaica, Cuba, Hayti (under which name I include San Domingo) and Porto Rico. As I have before remarked it is on these islands that the characteristic fauna of the West Indies is developed. There have been recorded from them 174 of the 300 birds peculiar to the West Indies. Of this number 169 are land-birds, and five are water-birds. They are distributed as follows :

Jamaica	66, of which 42 are endemic.
Cuba.....	68, " 45 "
Hayti	56, " 34 "
Porto Rico.....	46, " 25 "

Of the eighty-eight genera to which these birds belong, thirty, containing fifty-four species, are peculiar to the West Indies. They are distributed as follows :

With representatives in four islands	4
" " three "	3
" " two "	2
Peculiar to Jamaica.....	7
" Cuba.....	6
" Hayti.....	7
" Porto Rico.....	1

It will be observed that although Jamaica is but little larger than Porto Rico, and is more isolated from neighboring regions than any island of the group, it is nearly as rich in endemic species, and has one more peculiar genus than Cuba. The latter island is not only ten times as large as Jamaica, but its proximity to Florida has given it at least four forms which have evidently been derived from Florida species. They are *Colinus virginianus cubanensis*, *Campephilus bairdi*, *Colaptes chrysocaulosus*, and *Sturnella hippocrepis*. Hayti, although about seven times as large as Jamaica, has eight endemic species less, while Porto Rico, nearly as large as Jamaica, and favorably situated for the reception of Lesser Antillean species, has seventeen endemic species less than Jamaica, and but one genus is peculiar to the island.

It is evident that, as Wallace has said, the islands "were not peopled by immigration from surrounding countries while in the condition we now see them, for in that case the smaller and more remote islands would be very much poorer, while Cuba, which is not only the largest, but nearest to the mainland in two directions, would be immensely richer, just as it really is in migratory birds" (Distrib. Animals, Am. Ed., II, p. 66).

These facts in distribution, in connection with a study of hydrographic charts, give us the best clue to a past land connection between the West Indies and the mainland.

From the coast of Honduras and Nicaragua the Mosquito Bank extends northeastward for nearly two hundred miles, or over half the distance from the mainland to Jamaica. It is enclosed by the 100-fathom line, and is divided from the San Pedro Banks by a channel seventy-five miles in width, and having an average depth of 700 fathoms. The San Pedro Banks, some of which appear above the surface of the sea, while none are below twenty-five fathoms, reach to within thirty miles of the south shore of Jamaica, from which they are separated by a channel having a depth of 600 to 900 fathoms. An elevation therefore of 100 fathoms would leave only two channels, the wider seventy-five miles, between Jamaica and the mainland.

Wallace advances the theory of a complete land connection between Jamaica and Central America, and also between Cuba and Yucatan, and suggests the probability of an ancient land in

the area enclosed by these connections. This view, as we have seen, is supported by Dr. Sclater, who has proposed for this hypothetical region the name 'Præantillesia.' Recent soundings, however, tend to disprove this theory.

In this connection Prof. Agassiz remarks: "The deep soundings (over three thousand fathoms) developed by the 'Blake' south of Cuba, between that island and Yucatan and Jamaica, do not lend much support to the theory of an Antillean continent, as mapped out by Wallace, nor is it probable that this continent had a much greater extension in former times than now, judging from the depths found on both sides of the West Indian Islands" (l. c., p. 116).

While there is little ground, therefore, for the hypothesis of an Antillean continent, it is not impossible that the land connection I have just outlined between Central America and Jamaica may have existed. That there has been a closer connection between this island and the mainland both the disproportionately rich avifauna of Jamaica and the shallowness of the intervening sea give us good reason to believe, but that the island has ever been completely joined to the mainland there is abundant room for doubt; first, because of the scarcity of terrestrial mammalia in the West Indies; second, because of the restrictions of the avifauna.

The land mammals of the West Indies, exclusive of Bats, are included in the three genera *Solenodon*, *Plagiodontia* and *Capromys*. *Solenodon*, with a single species each in Hayti and Cuba, is remarkable as having its nearest relationships with *Centetes* of Madagascar. *Plagiodontia*, with one species in Hayti, is nearly allied to *Capromys*. *Capromys*, with five or six species, finds its nearest ally in *Dasyprocta*, which ranges from Mexico southward. Cuba has three species of *Capromys*, the Bahamas one, Jamaica one, and Swan Island one, Porto Rico being without a representative of the group. The recent discovery on Swan Island by Mr. C. H. Townsend of a species of *Capromys*, differing but slightly if at all from the Jamaican species, points strongly towards the former extension of land in this direction. Swan Island is about one hundred miles from the coast of Honduras, and sixty miles north of the Mosquito Bank, which reaches out towards Jamaica.

Our knowledge of West Indian Bats is as yet very incomplete. Comparison of Gundlach's lists of Cuban and Porto Rican species with Osborne's list of Jamaican species (using Dr. Dobson's determinations), results as follows: Of a total of nineteen species three are evidently of North American origin, and are recorded only from Cuba; seven are tropical, and nine are West Indian. Of fourteen genera four are West Indian. All the nine West Indian species have been found in Cuba, six have been recorded from Jamaica, and two from Porto Rico. This serves to emphasize the isolation of Porto Rico, and the richness of the Jamaican fauna as compared with the size of the island.

The discovery of the remains of extinct mammals on Anguilla is considered by Mr. Wallace as strong evidence in favor of a former Antillean continent, and he remarks that further exploration will undoubtedly result in the discovery of additional remains of extinct mammalia. We have seen that with little doubt Anguilla is a member of the Lesser Antilles, and has had no connection with the larger islands. The remains found there have, therefore, apparently no bearing on the present case.

The sixteen years which have elapsed since the publication of Mr. Wallace's work have not added to our recorded knowledge of the mammalian palæontology of the West Indies. While it is true there has been no direct search for fossil mammals, the fossil molluscan fauna has received the attention of eminent conchologists who have not reported the discovery of mammalian remains. That islands so well adapted to the support of a rich mammal fauna should be so poor in representatives of this class, is one of the strongest zoölogical arguments opposing a past continental connection. Comparison of the West Indian fauna, with the life of continental islands, presents a striking contrast. For example, Formosa, ninety miles from the mainland, and about one-fourth the size of Cuba, has, according to Wallace, no less than thirty-one species of terrestrial mammalia, including representatives of *Ursus*, *Felis*, *Sus*, *Cervus* and *Bos*.

Mr. Wallace accounts for the comparative absence of mammals in the West Indies by subsidence, which has greatly reduced the extent of the land. That there have been periods of subsidence in the West Indies is a geological fact. That the submergence

has been on so grand a scale as to result in the "almost complete annihilation of the mammalian fauna," does not, in view of the extensive development of older formations showing no traces of marine deposits, seem probable. Nor is it likely that in each island so defenseless an animal as *Capromys* would be almost the sole surviving species.

The absence from the West Indies of representatives of many families of birds found on the mainland is also evidence opposed to the theory of a past connection between these islands and the continent. With the exception of *Hadrostomus niger* on Jamaica, and *Colinus virginianus cubanensis* on Cuba, the following twelve families, all of which are found from Mexico southward, are without representatives in the larger West Indian Islands.

Troglodytidae.	Formicariidae.	Ramphastidae.
Pipridae.	Galbulidae.	Cracidae.
Cotingidae.	Bucconidae.	Tetraonidae.
Dendrocolaptidae.	Momotidae.	Tinamidae.

Examination of Zeledon's list of Costa Rican birds shows that in Costa Rica there are found no less than 140 species belonging to these families.

It is a significant fact that almost all these birds are either terrestrial or of sedentary habits. That is, they are birds which we should not expect to find occupying a prominent place in an insular avifauna. Their absence from the West Indies cannot with reason be attributed to subsidence, and is, therefore, a fact which must be explained before the theory of a continental connection can be accepted.

Summarizing this brief review of the more striking features of the West Indian fauna, we have, from the standpoint of birds and mammals, the following facts bearing on the question of a past connection between these islands and the mainland. In favor of this theory are, (1) the disproportionately rich fauna of Jamaica; (2) the shallow sea between this island and the mainland; (3) the West Indian affinities of Swan Island as shown by the presence of *Capromys*. Opposed to the theory of a land connection are, (1) the scarcity of land mammals; (2) the absence of representatives of many families of birds found on the mainland.

It seems to me, however, that these facts may be harmonized and made to support one another if we can show a reason for the belief, that if a connection existed between Jamaica and the Mosquito coast, it was at a time when the latter region was perhaps itself separated from the mainland by passages connecting the Pacific with the Caribbean Sea. Of such passages, Prof. Agassiz has said, "we find traces in the Tertiary and Cretaceous deposits of the Isthmus of Darien, of Panama, and of Nicaragua" (Three Cruises of the Blake, I, p. 113).

The same author continues: "Central America and northern South America at that time must have been a series of large islands with passages leading between them from the Pacific into the Caribbean." If this supposition be correct, it is quite possible that the families of birds which we have seen are not represented in the West Indies were not at that time found in Central America, and that they have appeared there only since the land connection with South America has been formed. Previous to this time, however, the West Indies had become detached.

This view is supported by the fact that of the twelve families of birds named all but the *Troglodytidae* and *Tetraonidae* extend but little north of Southern Mexico. And further, with the two exceptions noted, the Central American and Mexican representatives of these families are in many instances co-specific with the South American forms, and but few peculiar genera have been developed north of the Isthmus. This would seem to indicate the recent appearance of these birds in this region. On the other hand the families to which the endemic West Indian birds belong are represented in Mexico and Central America by many peculiar genera.

In accordance with this hypothesis we may divide the West Indian fauna into two groups, the first of which was derived during the land connection just suggested, while the second owes its origin to migration, or the more or less fortuitous appearance of birds from surrounding regions. From the nature of the case the line between these two groups cannot be sharply drawn.

Capromys, *Solenodon*, *Mimocichla*, *Spindalis*, *Saurothera* and *Todus*, etc., are representatives of the former, while the slightly differentiated forms of *Mimus*, *Certhiola*, *Myiarchus*, and the

close allies of Florida birds found in Cuba, belong to the latter. The fact that many of the older genera have representatives on each of the islands would seem to indicate a past direct or indirect connection between the islands of the group. The generally close relationships which exist between the species of these genera points to the conclusion that they are derived from a common ancestor differing but slightly from the present type.

If we assume that the West Indies were separated sometime during the Middle Tertiary, we may then regard these older forms as survivors of the fauna of that period, which have been preserved to us through the isolation afforded by an insular life. This supposition is supported by the fact that they are quite as distinct from existing genera as are the genera of birds which have been described from the Miocene.

The isolation which has protected these old types has also resulted in the differentiation of the species derived through migration. Thus while the West Indies have preserved to us species which on the mainland have succumbed to the continental struggle for existence, they have given us many new forms which have been differentiated from their mainland ancestors under the influences of a new environment.

**Article XVII.—ON A COLLECTION OF BIRDS FROM
CHAPADA, MATTO GROSSO, BRAZIL, MADE BY
MR. H. H. SMITH.**

By JOEL ASAPH ALLEN.

PART II.—TYRANNIDÆ.

(Continued from Vol. III, p. 380.)

The present Part treats only of the family Tyrannidæ, which is represented by 45 species. In treating of *Myiarchus tyrannula*, reference is also made to its West Indian, Mexican and United States allies, at one time considered by several ornithologists of repute as merely subspecies of the *M. tyrannula* group.

Since the publication of Part I the Museum has purchased the remainder of the Smith Collection of Chapada birds (see this Bulletin, Vol. III, p. 337), thus increasing the number of duplicates available for exchange.¹

88. *Tænioptera nengeta* (Linn.).—A series of 59 specimens, divided about equally between males and females, represents every month in the year except October, as follows: January, 4; February, 4; March, 7; April, 9; May, 5; June, 7; July, 4; August, 4; September, 2; October, 0; November, 6; December, 6.

The plumage in the November and December specimens is much faded and worn. The molt begins in December, and the new clothing plumage is pretty well acquired before the end of January, but the molt of the quills continues irregularly till into April. As a rule, however, March and April birds are in good condition, but the highest condition of plumage is seen in the May and June specimens. The females average a little smaller than the males, but there is no very appreciable difference in coloration. By August the plumage begins to show signs of deterioration. In old males the tips of the first and second primaries are more or less incised on the inner vane, but much less so than in some other species of the genus.

¹ I have learned since the publication of Part I that the credit for gathering and preparing the collection is about equally due to Mrs. H. H. Smith and Mr. W. C. Smith, the latter preparing most of the birds collected during 1883-84.

A bird of the year, in first plumage, taken Dec. 19, has the white of the lower plumage tinged with pale buff, and the gray of the upper plumage with brownish, the rump and upper tail-coverts being decidedly brown; the tips of the wing-coverts are buffy white instead of grayish white.

The measurements of 10 adults of each sex are as follows: *Males*: wing, 5.02-5.68, averaging 5.39; tail, 3.20-3.76, averaging 3.58; culmen, .70-.82, averaging .76. *Females*: wing, 4.90-5.34, averaging 5.19; tail, 3.42-3.74, averaging 3.56; culmen, .70-.80, averaging .75.

89. *Tænioptera velata* (Licht.).—Three specimens—Cachoeira, ♂ ad., Feb. 4, 1886; Chapada, ♂ ad., Sept. 23, 1883, ♀ ad., Dec. 6, 1883.

90. *Fluvicola albiventris* (Spix).—One specimen, Corumba, March 24, 1886.

91. *Arundinicola leucocephala* (Linn.).—Four specimens, 2 males and 2 females, Corumba, March, 1886.

92. *Alectrurus tricolor* Vieill.—One specimen, ♂, June, 1883.

93. *Cnipolegus comatus* (Licht.).—Six specimens, 5 of which are males, taken as follows: January, 1; July, 1; August, 3; October, 1.

94. *Copurus colonus* (Vieill.).—Three specimens, November, 1882 and 1883. Two are adults and the other young, in the black plumage=*C. funebris* Cab. & Heine (Mus. Hein., II, 1859, p. 41).

95. *Platyrrhynchus bifasciatus* Allen.—As already stated (this Bulletin, II, No. 3, 1889, pp. 141, 142) this species is represented by 18 specimens, 11 males and 7 females, all from Chapada. The series having been already fully described (l. c.) further remarks are not necessary.

96. *Todirostrum cinereum* (Linn.).—The series of 13 specimens was collected as follows: Chapada, April (2 specimens) and August (5 specimens); Corumba, 6 specimens—February,

March, and April. Of these specimens 7 are sexed as males, 4 as females, and 2 are not marked for sex, but are doubtless females. In all there is a very narrow frontal band of yellow at the base of the bill, in some, however, scarcely discernable. The females are distinguishable from the males by a very small spot of white (sometimes yellowish white) on the middle of the crown, but apparently are not otherwise different from the males. There is, however, much variation in color and size, and especially in the size of the bill, but it is apparently individual and seasonal rather than sexual. The 7 males measure as follows: wing, 1.58–1.88, averaging 1.77; tail, 1.36–1.46, averaging 1.43; culmen, .52–.58, averaging .55. The 6 females measure; wing, 1.66–1.80, averaging 1.70; tail, 1.28–1.40, averaging 1.34; culmen, .52–.57, averaging .54.

97. *Euscarthmus ochropterus* Allen.—Chapada, 15 specimens. There is nothing to add to the description of this species already given (see this Bulletin, II, No. 3, June, 1889, pp. 143, 144).

98. *Euscarthmus pelzelni* Scf.—One specimen, Chapada, May 23, 1885.

99. *Euscarthmus striaticollis* (Lafr.).—Two specimens, Chapada, ♂ ad., Feb. 18; ♀ ad. (no date).

100. *Hapalocercus meloryphus* (Wied).—One specimen, Chapada, Aug. 25.

101. *Habrura pectoralis* (Vieill.).—Chapada, 10 specimens—May, 2; July, 2; August, 4; September, 2. These specimens have already been commented upon in a comparison between *H. pectoralis* and *H. superciliaris* (Wied). (See this Bulletin, II., No. 3, June, 1889, p. 146.)

102. *Culicivora stenura* (Temm.).—One specimen, Chapada, ♀ ad., April 13.

103. *Serpophaga albogrisea* Scf. & Salv.—Three specimens, taken as follows: Abrilongo, ♂ ad., Feb. 28; Chapada, ♂ ad., July 20; juv. in first plumage, Nov. 6. The young bird

is brown above, with each feather narrowly edged with whitish; below, throat and breast dark ashy brown, faintly cross-barred with darker brown; rest of lower parts whitish with a faint tinge of greenish buff; under wing-coverts greenish yellow; wings and tail dusky brown.

104. *Leptopogon amaurocephalus* Cab. — Chapada, 10 specimens, collected as follows: February, 2; May, 1; June, 2; August, 1; November, 4. There is apparently very little seasonal or sexual variation, the series being remarkably uniform as regards both size and coloration. In November specimens the cap is paler, and the wing-bars are pale yellowish instead of ochraceous, as in the birds in fresher plumage. One of the specimens has the cap but little darker than the back and the wing-bars yellowish, thus resembling closely the description of *L. tristis* of Sclater and Salvin from Bolivia.

Six males measure as follows: wing, 2.47–2.67, averaging 2.56; tail, 2.06–2.33, averaging 2.20; culmen, .47–.52, averaging .50. Three females measure as follows: wing, 2.40–2.45, averaging 2.42; tail, 2.07–2.09, averaging 2.08; culmen, .50–.52, averaging .50.

On comparison with Panama specimens of *L. pileatus* Cab., the differences prove to be almost inappreciable. The brown-headed group of this genus, embracing *L. amaurocephalus*, *L. pileatus* and *L. tristis*, apparently constitute a widely dispersed species, perhaps barely separable into two or three geographical subspecies, the Central American form standing as *L. a. pileatus*, and the Bolivian form, if really separable, as *L. a. tristis*.

105. *Myiopatis semifusca* Scl. — Chapada, 6 specimens — April, 2; May, 1; August, 1; September, 2. The abdomen varies in different specimens from silky grayish white, faintly tinged with greenish, to a deep tinge of pale sulphur yellow.

106. *Ornithion cinerascens* (Wied) = *O. obsoletum* auct. (See this Bulletin, II, No. 3, June, 1889, pp. 148, 149.)

This species is represented by 12 specimens, taken at Chapada, as follows: February, 1; March, 1; April, 1; May, 2; June, 3; July, 1; August, 2; September, 1.

These specimens vary much in both color and size, the males being much larger than the females, and the coloration varying greatly with season. The brightest colored specimen is a male taken Sept. 17; the palest is a female, taken July 6. In the former the head is ashy olivaceous brown, the back strong greenish olive, the rump distinctly browner; wing-bars rusty ochraceous; below, throat olivaceous gray; rest of lower parts strongly washed with yellowish olive; edge of wing pale ochraceous. In the July specimen the head is much darker, with a distinctly dusky cap, the back grayish brown faintly tinged with olive, the wing-bars grayish white faintly tinged with ochraceous basally; below, throat and breast dull gray with a slight olivaceous cast, rest of lower parts grayish white, lighter (nearly white) on the middle of the abdomen, and washed with pale yellowish olive on the flanks. Between these extremes is nearly every stage of intergradation, clearly due to various seasonal phases.

The following measurements of 12 specimens (3 males, 4 females, and 5 unmarked for sex) show the range of variation in size. Wing, 2.00-2.25, averaging 2.09; tail, 1.46-1.78, averaging 1.61; culmen, .25-.32, averaging .28. The females are apparently slightly smaller than the males.

As already noted (l. c.) the *Ornithion obsoletum* of modern writers is the *Hylophilus cinerascens* Wied, as shown by his types, still extant in this Museum.

107. *Elænea pagana* (Licht.).—Of the 112 specimens of the *E. pagana* group from Chapada, about 48 per cent. are referable to *E. pagana* proper, and 40 per cent. to *E. pagana albiceps*, while the remaining 12 per cent. are variously intermediate between the two forms. As this material has already been made the subject of a special paper (see this Bulletin, II, No. 3, Oct., 1889, pp. 183-208), further comment is here unnecessary. Every month in the year except June is represented by a considerable series of specimens, rendering it possible to trace the seasonal phases of coloration throughout the year.

108. *Elænea pagana albiceps* (d'Orb. & Lafr.).—See above under *E. pagana*.

109. *Elænea gaimardi* (d'Orb.).—Three specimens, taken respectively Feb. 19, June 10, 1885, and July 27, 1883. Apparently a rare species at Chapada.

110. *Elænea viridicata* (Vieill.) = *E. placens* Scf.—One specimen, April 2, 1883.

There seems to be no reason to question the pertinence of Vieillot's *Sylvia viridicata* to this species.

111. *Elænea affinis* Burm.—This species is represented by 8 specimens, taken as follows: February, 3; March, 1; May, 3; December, 1.

The February and March specimens, in fresh unworn plumage, are more olive on the back than the May specimens. The December specimen is in molt, about one-half of the plumage being worn and faded, with which is mixed the freshly acquired and more olive new plumage.

Besides this well-marked seasonal difference in coloration, there is a wide range of individual variation in size, and a most remarkable variation in the size and shape of the bill, to which latter attention has already been called. (See this Bulletin, II, No. 3, 1889, pp. 191 and 207, and figs. 9-12 and 9a-12a.)

The 8 specimens measure as follows: 3 *Males*: wing, 3.32-3.44, averaging 3.39; tail, 2.58-2.92, averaging 2.74; exposed culmen, .50-.60, averaging .54. 5 *Females*: wing, 3.12-3.30, averaging 3.23; tail, 2.60-2.85, averaging 2.69; exposed culmen, .40-.56, averaging .48. The females are thus much the larger.

112. *Legatus albicollis* (Vieill.).—One specimen, ♂, Oct. 20, 1882.

113. *Sublegatus griseocularis* Scf. & Salv.—Of the 9 specimens representing this species 1 was taken in January, 1 in February, 1 in March, 1 in May, and 5 in August. They present the usual amount of seasonal variation in color, and also vary greatly in size, the larger specimens closely approaching Venezuela specimens of *S. glaber* in length of wing, but the bill is always very much smaller.

The measurements of seven adult specimens range as follows: 5 *Males*, wing, 2.52-2.62, averaging 2.57; tail, 2.14-2.22, averag-

ing 2.20; exposed culmen, .26-.37, averaging .31; 2 *Females*, wing, 2.57-2.66, averaging 2.61; tail, 2.16-2.22, averaging 2.19; exposed culmen, .32.

114. *Sublegatus virescens* Allen.—The type and only known specimen of this species was taken at Chapada May 8, 1885. There is nothing to add to the description already given (this Bulletin, II, No. 3, 1889, p. 149).

115. *Myiozetes cayennensis* (Linn.).—The three specimens representing this species I am unable to distinguish from true *M. cayennensis* from northern South America and Panama. Two were taken in January, the other in August.

It may be mentioned in this connection that the type of *M. rufipennis* Lawr., from Venezuela, referred to *M. cayennensis* by Mr. Sclater (Cat. Bds. Brit. Mus., XIV, p. 160), is referable to *M. erythropterus*, with which it agrees perfectly in coloration.

116. *Rhynchocyclus sulphureus* (Spix).—Represented by 6 specimens, taken as follows: ♀ ad., April 10; ♂ ad., May 2; ♀, Nov. 1; ♀ juv., Nov.; ♂ ad., Dec. 2.

In several of the specimens the auriculars are distinctly blackish posteriorly, in some cases forming a well-defined spot, mentioned as a feature of *R. peruvianus* Tacz.

NOTE.—Mr. Lawrence's *R. flavo-olivaceus* (Ann. New York Lyc. N. H., VIII, 1863, p. 8), of which the type is before me, represents the northern form of *R. sulphureus*, and apparently may easily stand as a subspecies, under the name *R. sulphureus flavo-olivaceus* (Lawr.). It is erroneously referred by Mr. Sclater (Cat. Bds. Brit. Mus., XIV, 1888, p. 169) to *R. cinereiceps*.

On the other hand, Mr. Lawrence's *R. marginatus* (Proc. Acad. Nat. Sci. Phila., 1868, p. 429), of which the two types are before me, is apparently a very distinct species, its nearest ally being *R. cinereiceps* Scl. Mr. Sclater erroneously refers it (l. c.) to *R. sulphureus*, to which it is not at all closely related.

117. *Pitangus derbianus bolivianus* (Lafr.).—One specimen, ♂, Abrilongo, Feb. 23.

118. *Sirystes sibilator* (Vieill.).—Nine specimens, collected as follows: 1 in February, 3 in March, 1 in May, 1 in July, 1 in August, 1 in September, and 1 in October.

119. *Myiodynastes solitarius* (Vieill.).—The 5 specimens were taken, 1 in September, 2 in October, and 2 in November.

120. *Megarhynchus pitangua* (Linn.).—This species is represented by 10 specimens, taken as follows: March, 1; July, 2; September, 3; October, 1; November, 3.

One of the November specimens is a young bird in first plumage. It differs from the adult in having a much smaller bill, in lacking the concealed orange patch on the crown, in having the dorsal plumage brown (lacking the olive tinge of the adults), with all of the feathers broadly edged with pale rufous; and in the lower parts being clear pale sulphur yellow instead of deep yellow.

121. *Hirundinea bellicosa* (Vieill.).—Four specimens: December, 1; January, 2; July, 1.

122. *Pyrocephalus rubineus* (Bodd.).—This species is represented by 74 specimens, nearly all taken May to September inclusive. April is represented by 7 specimens and October by 2. No specimens were taken between Oct. 7 and April 10, and only 2 prior to April 22. It would thus seem that the species is absent from the vicinity of Chapada from early in October till early in April.

This species appears to undergo a double molt annually—a complete molt, probably in November and December, and a partial molt (the clothing plumage only) in May and June. This partial molt begins in April, and some males continue in mixed livery till September, the males probably not acquiring fully adult plumage till the second, and possibly not till the third year. The five males taken in April are all in the garb of the female, with here and there red feathers coming in on the crown, throat and breast; the crissum and lower flanks are orange red.

Of the May series of 10 males, 6 have partly acquired full breeding plumage, the crown being still more or less patched with brown, and the throat, breast and flanks streaked with whitish

and dark brown, the red, however, greatly prevailing. The others have merely here and there a red feather on the crown, throat and breast. Of the 7 June males, one (taken June 30) is very nearly in perfect breeding plumage, four others are in mixed plumage with the red prevailing, while the other two show only here and there red feathers.

Of the 8 July males, four are in full breeding dress, three are more or less mottled with remnants of the immature plumage, while the other has here and there a few red feathers. Of the 6 August males, five are in full breeding dress, and the sixth is in mixed plumage. Of the 8 September males six are in full breeding dress, one has the red feathers of the throat and breast streaked with blackish, and the other is in mixed plumage. The single October male is in full breeding plumage. It thus appears that even in July, August and September a small proportion of the males are in mixed dress, having only scattered patches of red, while another small proportion have the red crown still more or less mixed with brown, and many of the red feathers of the lower plumage edged with whitish and broadly centered with blackish. This serves to divide the males into three categories—adult males (comprising about two-thirds of all), males of the second year, and males of the preceding year.

The females also exhibit much variation. A few are nearly uniform below, presenting little or no buffy yellow, orange or red on the lower flanks and crissum; the greater number have these parts suffused with yellowish buff, while in a few others they are pale red or orange red. This variation may be due also to differences of age.

The measurements of 10 adult males (in full breeding dress) and 10 adult females range as follows: *Males*: wing, 2.96-3.07, averaging 3.02; tail, 2.10-2.20, averaging 2.15; culmen, .44-.50, averaging .47. *Females*: wing, 2.80-3.12, averaging 2.96; tail, 1.97-2.30, averaging 2.14; culmen, .41-.48, averaging .45.

Pyrocephalus rubineus mexicanus, from Mexico and the southern border of the United States, as is well known, is rather lighter in coloration, both above and below, and is commonly supposed to be rather smaller than the South American *P. rubineus*. This, however, proves to be erroneous, the South American bird being

the larger. For purpose of comparison I append measurements of 10 adult males and 5 adult females, from Pinal County, Arizona, collected by Mr. W. E. D. Scott. 10 *Males*: wing, 3.12-3.24, averaging 3.16; tail, 2.14-2.32, averaging 2.22; culmen, .42-.48, averaging .45. 5 *Females*: wing, 3.08-3.10, averaging 3.09; tail, 2.18-2.26, averaging 2.21; culmen, .44-.46, averaging .45. This shows an average difference of .14 of an inch in the length of the wing in 10 adult males of each form, respectively from Arizona and Southern Brazil, the *latter being the smaller*. Six specimens from Ecuador and Colombia average slightly larger than the Chapada birds.

123. *Myiobius navius* (Bodd.).—The 6 specimens representing this species were taken as follows: Abrilongo, February, 1; Chapada, 2 in July, 1 each in August, September and October. In all the concealed vertical crest is yellow; two are sexed as males, two as females, and the others are not marked for sex.

124. *Empidochanes fuscatus* (Wied.).(=*E. fuscatus* et *E. fringillarius* auct.)—The series of 25 specimens of this species were taken as follows: in May, 6; in June, 1; in July, 2; in September, 9; in October, 3; in November, 2; in December, 2. It presents a considerable range of both individual and seasonal variation in color. The May specimens, being in fresh unworn plumage, are of a deeper brown above, with a slight tinge of yellowish below, which in one specimen (taken May 12) is quite strong. In the September-December specimens the upper parts are much duller (more olivaceous) brown, and the faint yellowish wash on the lower parts has given place to a silky grayish white. The bill varies from nearly uniform dusky horn color (in some specimens nearly black) with the lower mandible usually a little lighter than the upper, to a much lighter brown, with the lower mandible light horn color, the basal half paling to a much lighter shade.

A young bird in first plumage (♂, Dec., 1882) differs from adults in having the upper plumage of a lighter, more rusty brown, with broader rusty edgings to the coverts and quills.

The present series of 25 specimens, all from the same locality, is not only far from uniform as regards coloration, but varies

widely in respect to measurements. The bill, as in Flycatchers generally, and especially in *Elanea*, *Ornithion*, *Empidonax*, and allied genera, is exceedingly variable in form (its variability in color has already been noted above). The two extremes might readily be referred to different genera, so far as the bill is concerned. In the one case the bill is short and very broad at the base, in the other it is very long, with the breadth at the base actually much less than in the short-billed phase. This wide difference, however, seems merely individual, since the other specimens show a complete intergradation between the extremes.

The following measurements show the large range of variation in size: 18 specimens: wing, 2.47-2.82, averaging 2.66; tail, 2.32-2.78, averaging 2.58; culmen, .48-.54, averaging .52. Very few of the specimens are marked as positively identified for sex, but so far as the evidence goes there appears to be no sexual difference in size.

From the foregoing I am led to doubt the distinctness of *E. fringillarius* Pelzeln from *E. fuscatus* Wied, the types of which latter are before me. The *E. arenaceus* (Scl. & Salv.) from Venezuela is apparently quite distinct from *E. fuscatus*.

125. *Empidonax bimaculatus* (d'Orb. & Lafr.).

Muscicapa bimaculata D'ORB. & LAFR. Syn. Av. (Mag. de Zool. 1837), p. 48; D'ORB. Voy. Ois. p. 320.

Empidonax bimaculatus SCL. Ibis, 1887, 65; Cat. Bds. Brit. Mus. XIV, 1888, p. 224.

Empidochanes euleri CAB. Journ. f. Orn. 1868, p. 195.

Empidonax brunneus RIDGW. Hist. N. Am. Bds. II, 1874, p. 263; Ibis, 1888, p. 463.

Empidochanes argentina CAB. Journ. f. Orn. 1868, p. 196.

This species is represented by 17 specimens, taken as follows: in January, 2; in February, 2; in March, 1; in April, 1; in May, 4; in July, 1; in September, 1; in October, 4; in November, 1. It is thus in all probability a resident bird.

The series presents the usual wide range of variation, in part seasonal and in part individual, with in addition much variation due to age. In freshly-molted birds the whole dorsal plumage is rufescent olive brown, with the head slightly darker; the lower surface is grayish white strongly tinged with pale sulphur

yellow, the breast strongly washed with olive; the wing-bars and the edging of the quills pale ochraceous. In worn plumage there is rather less olive, both above and below, and the wing-bars are paler. In young birds the whole dorsal surface is more rusty olive, with the head strong ochraceous brown; the coverts and quills are more broadly edged with ochraceous, and there is usually a distinct third wing-bar, formed by the rusty ochraceous tips of the least wing-coverts. Below the broad olive breast-band is somewhat brownish. This phase (represented by four specimens) appears to represent the *Empidochanes euleri* of Cabanis, while the more or less faded post-breeding specimens appear to represent his *Empidochanes argentinus*. My *Empidonax bolivianus* and *E. lawrencei* (= *Ochthaea flaviventris* Lawr.) belong to the same group, but appear clearly separable, so far as present material goes. (See this Bulletin, II, No. 3, pp. 86 and 150.)

The measurements of 11 adult specimens show the following range of variation: 6 *Males*: wing, 2.50–2.62, averaging 2.54; tail, 2.27–2.49, averaging 2.36; exposed culmen, .45–.50, averaging .49. 5 *Females*: wing, 2.36–2.52, averaging 2.45; tail, 2.20–2.43, averaging 2.29; exposed culmen, .44–.46, averaging .46. The females thus average considerably smaller than the males.

126. *Myiarchus tyrannulus* (Mull.) (*M. erythrocerus* ScL., and of many authors).—The 34 specimens representing this species indicate that it is a permanent resident at Chapada. They were collected as follows: in January, 1; February, 0; March, 2; April, 1; May, 5; June, 3; July, 8; August, 8; September, 3; October, 1; November, 0; December, 2.

The amount of rufous on the inner vane of the outer tail feather is very variable, ranging from none whatever to a border occupying from one-third to two-thirds of the width of the inner vane. Four specimens show none whatever, and there is much less than the usual amount on the inner vanes of all the other rectrices; two show only a trace of a faint tinge of rufous on the inner vane of the second feather, while all of the rectrices are without rufous on the apical third of the feather. In others there is only a faint trace of pale rufous along the edge of the basal third of the inner vane of the outer feather. In still

others it is of the usual width but very pale, sometimes becoming wholly obsolete towards the tip. The rufous margin of the inner vane of the rectrices thus varies not only greatly in extent but also in the depth of the rufous tint. Apparently the variation is purely individual, as young birds in first plumage present the same diversity in this respect as the adults.

In young birds the yellow and the gray is paler than in adults; the head, lower back and upper tail-coverts are rusty brown, decidedly in contrast with the back, and the quills of the wings and tail are more broadly edged with rusty.

There is the usual seasonal variation in color, due to wear and fading. The bill is brownish black, becoming often deep black, however, in the breeding season; it also varies greatly in respect to size and form. There is considerable variation in general size, but this is in large part sexual, as shown by the following measurements: 10 *Males*: wing, 3.56-3.82, averaging 3.67; tail, 3.20-3.58, averaging 3.36; exposed culmen, .70-.76, averaging .73. 8 *Females*: wing, 3.50-3.68, averaging 3.59; tail, 3.15-3.40, averaging 3.28; exposed culmen, .68-.76, averaging .72. *General average*, wing, 3.63; tail, 3.32; culmen, .72.

The relationship of the widely dispersed South American *M. tyrannulus* to certain closely allied West Indian, Central American and Mexican forms has been the subject of much comment, and and of much diversity of opinion among authors. As the large series of *M. tyrannulus* from Chapada affords a favorable basis for a renewed examination of the points at issue, I offer a short *résumé* of the subject based on a much larger amount of material than has previously been brought together.¹

True *Myiarchus tyrannulus*, it may be premised, is not known from Central America, while *M. mexicanus*, its closely related North American representative, is not known from south of the southern boundary of Mexico. Another form closely related to these, *Myiarchus oberi*, has an extensive range in the Lesser

¹ In this connection I wish to acknowledge my indebtedness to Mr. Robert Ridgway, Curator of Birds in the U. S. National Museum, for the use of the large series of *Myiarchus* from southern Mexico, Central America and the West Indies contained in the National Museum, including the types of Mr. Ridgway's *M. nuttingi* and *M. brachyurus*, and of Mr. Lawrence's *M. oberi*. I am also indebted to Mr. George B. Sennett for his series of nearly 200 specimens from Texas and eastern Mexico, while our own Museum contains a large number of specimens from Arizona, Mexico and Central America, giving a total of over 300 specimens of the section of the genus *Myiarchus* with rufous-edged rectrices. Our Museum series contains the types of Mr. Lawrence's *M. yucatanensis* and *M. cinerascens*.

Antilles. These form what may be termed the *M. tyrannulus* group. *M. mexicanus* is represented by two forms, as follows: (1) *M. mexicanus*, of southern and eastern Mexico, ranging north to southern Texas; and (2) *M. mexicanus magister*, of western Mexico, ranging north into Arizona.

Myiarchus oberi Lawr. (Ann. New York Acad. Sci., I, 1877, p. 48), from the Lesser Antilles, is larger and darker than *M. tyrannulus*, with the bill longer, narrower, deeper and blacker. A series of 15 specimens (5 males, 7 females, and 3 not marked for sex, from Dominica, Granada, St. Vincent, etc.) measure as follows, the males as usual proving a little larger than the females: wing, 3.44-4.08, averaging 3.76; tail, 3.16-3.88, averaging 3.53; exposed culmen, .74-.90, averaging .83.

Myiarchus mexicanus (Kaup)¹ is larger than even *M. oberi*, and also differs from it in its paler colors and broader, flatter bill. It is consequently much larger than *M. tyrannulus*, and has a relatively larger bill. While there is but little difference in the general coloration, the rufous on the inner vanes of the rectrices is rather broader and much more uniform in development, especially on the outer rectrix.

Myiarchus mexicanus magister (Ridgw.) is scarcely distinguishable in coloration from *M. mexicanus*, when specimens strictly comparable as to season are compared. There is, however, considerable average difference in size, so that the two forms are very fairly entitled to recognition, as shown by the following measurements, where Arizona specimens (*M. m. magister*) are compared with specimens from the Lower Rio Grande (*M. mexicanus*).

Lower Rio Grande Valley (Hidalgo, and Lomita Ranch, Texas; Coll. George B. Sennett), 12 males and 12 females: *Males*: wing, 3.90-4.22, averaging 4.04; tail, 3.50-3.85, averag-

¹ I accept Dr. Sclater's conclusions (P. Z. S., 1871, p. 84) respecting Kaup's troublesome name *Tyrannula mexicana* as against Mr. Salvin's later opinion (Biol. Centr.-Am. Aves, II, 1889, p. 91), since Mr. Salvin admits that in the specimens "compared with Kaup's type," "the tip of the inner web of the outer tail-feather is rufous," and thus not like "typical *M. cinerascens*," to which, nevertheless, he refers Kaup's *Tyrannula mexicana*. If there be still any reason for doubt in the matter it seems better, in the interest of stability of nomenclature, to consider the case as settled by Dr. Sclater's comparisons, especially since the name *M. mexicanus* Sclater, if not the *Tyrannula mexicana* of Kaup, is the well-established cognomen of the bird so well characterized by Baird in 1850 as *Myiarchus cooperi*.

What the *Tyrannula cooperi* of Kaup was may never be determined, the type having been lost. Fortunately this is not important, since *Tyrannula cooperi* Kaup (1851) is forestalled by *Tyrannula cooperi* Bon. (1850) = *Muscicapa cooperi* Nutt. (1832) = *Tyrannus borealis* Swain (1831).

ing 3.64; exposed culmen, .77-.85, averaging .80. *Females*: wing, 3.67-3.92, averaging 3.79; tail, 3.30-3.58, averaging 3.46; exposed culmen, .74-.84, averaging .78. *General average*: wing, 3.91; tail, 3.55; culmen, .79.

Arizona (Pinal County), 6 males and 5 females: *Males*: wing, 4.24-4.46, averaging 4.33; tail, 3.91-4.22, averaging 4.04; exposed culmen, .84-1.00, averaging .94. *Females*: wing, 4.02-4.16, averaging 4.10; tail, 3.65-3.95, averaging 3.76; exposed culmen, .82-.98, averaging .88. *General average*: wing, 4.22; tail, 3.90; culmen, .92.

For fully twenty years these two forms have been practically recognized by American ornithologists.¹ It was not, however, till 1884 that they were clearly defined, when they were formally separated by Mr. Ridgway and their respective habitats defined.² Series from southern Mexico commonly include both forms, and also intermediate examples, the latter perhaps being resident birds and the former migrants from the north.

Myiarchus yucatanensis Lawr. (Proc. Acad. Nat. Sci. Phila., 1871, p. 235) was formerly referred by various writers to *M. mexicanus*. Of late, however, it has been currently accorded the rank of a species.³ Mr. Ridgway (l. c.) and Dr. Sclater (l. c.) consider it as nearly related to *M. stolidus* of Jamaica, while Mr. Salvin (l. c.) compares it with *M. lawrencei*, to which it certainly bears a very close resemblance. The two original specimens (No. 42,841, Am. Mus. Nat. Hist., marked "type" by Mr. Lawrence himself, and No. 39,213, U. S. Nat. Mus.) are both in very worn plumage, and were these the only specimens known I should not hesitate to refer them to *M. lawrencei*. I am, therefore, quite willing to accept Mr. Salvin's view that there is "very little difference between these Yucatan birds (*M. yucatanensis*) and the form of *M. lawrencei* found in eastern Mexico from Vera Cruz northwards." While the types bear a strong resemblance

¹ Cf. Coues, Proc. Acad. Nat. Sci. Phila., 1872, pp. 65-79; Baird, Brewer and Ridgway, Land Birds N. Am., II, 1874, p. 331; Coues, Bull. U. S. Geol. Surv., IV, 1878, p. 32; Ridgway, Proc. U. S. Nat. Mus., I, 1878, p. 139.

² Proc. Biol. Soc. Washington, II, p. 90. See also further, Ridgway, Man. N. Am. Birds, 1887, p. 333.

³ Cf. Ridgway, Proc. Biol. Soc. Washington, II, 1884, p. 92; Man. N. Am. Birds, 1887, p. 334; Sclater, Cat. Birds Brit. Mus., XIV, 1888, p. 260; Salvin & Godman, Biol. Centr.-Am., Aves, II, 1889, 93.

in coloration to worn specimens of *M. tyrannulus*, in which the amount of rufous in the tail is below the normal, this is evidently not the species to which they bear the closest affinity.

Mr. Ridgway's *Myiarchus nuttingi* (Proc. U. S. Nat. Mus., V, 1882, p. 394) barely needs mention in the present connection, its affinities being with *M. cinerascens* rather than with the *M. mexicanus* group. It is peculiar in having generally the whole inner vane of the outer retrix rufous; in some specimens there is, however, a narrow dusky line on the inner side of the shaft near the tip, which, in exceptional specimens, broadens considerably apically. Such examples are hard to distinguish from occasional specimens of *M. cinerascens* in which the dusky spot at the tip of the inner vane is narrow, or not abruptly widened near the tip of the feather, as sometimes happens even in Arizona specimens of *M. cinerascens*.¹ Such examples may also be compared with small specimens of *M. mexicanus* in which the rufous on the inner vane of the outer retrix closely approaches the shaft. *M. nuttingi* is doubtless well entitled to recognition as a subspecies of *cinerascens*, under the name *M. cinerascens nuttingi* (Ridgw.).

Mr. Ridgway's *M. brachyurus* (Man. N. Am. Birds, 1887, p. 334) appears to be not clearly separable from *M. nuttingi*. There is no appreciable difference in coloration, while the habitat of *M. nuttingi* (southern Mexico to western Costa Rica) includes that of *M. brachyurus* (Nicaragua). The supposed difference between the two birds is thus essentially one of proportions respecting the relative length of the wing and tail, and is probably based on individual variation.

127. *Myiarchus ferox* (Gmel.) (*Myiarchus tyrannulus* of many authors, not of Müll.).—The 25 specimens of this species represent every month in the year, except July, as follows: January, 2; February, 3; March, 2; April, May and June, 1 each; July, 0; August, 4; September, 4; October, 3; November, 3; December, 1.

¹ Since the above was written three specimens of alleged *M. nuttingi* have been recorded from Arizona (Fisher, Auk, IX, Oct., 1892, 394). Through the kindness of Dr. A. K. Fisher I have had opportunity to compare them with a large series of Arizona and Mexican specimens. The subject has also come before the A. O. U. Committee on 'Classification and Nomenclature of North American Birds,' which, after due consideration, reached the conclusion that *M. nuttingi* is merely a smaller southern form of *M. cinerascens* (see Auk, X, Jan., 1893, p. —).

The single December specimen is a bird of the year in first plumage. Below it scarcely differs from the adults; above the whole plumage is darker, the head decidedly rusty brown, the rump rufous, and the quills of the wings and tail broadly edged with bright rufous, and all the wing-coverts are edged broadly with grayish rufous. A January specimen in molt still retains part of the first plumage, the unmolted portions agreeing with the December specimen above described, part of the wing and tail feathers being rusty edged, etc.

The January and February specimens are all in molt. In freshly-molted birds (taken March to May) the color above is darker, and the gray of the throat and breast, and the yellow of the abdomen, are much deeper and stronger than in the specimens taken toward the close of the breeding season, which have become much lighter (especially more ashy above) through fading.

The measurements of 20 specimens, 12 males and 8 females, range as follows: *Males*: wing, 3.22-3.68, averaging 3.44; tail, 3.04-3.40, averaging 3.26; exposed culmen, .66-.72, averaging .69. *Females*: wing, 3.28-3.42, averaging 3.36; tail, 2.92-3.40, averaging 3.21; exposed culmen, .65-.72, averaging .69.

Mr. Lawrence's *Myiarchus venezuelensis* (Proc. Acad. Nat. Sci. Phila., 1865, p. 38) is a bird in fresh plumage (the type is before me) with the outer vanes of the tail-feathers conspicuously edged with bright rufous. It is probably not separable from *M. ferox*. The same author's *Myiarchus panamensis* (Ann. New York Lyc. Nat. Hist., VII, 1860, p. 284) seems entitled to rank as a larger northern form of *M. ferox*, and may be recognized as *M. ferox panamensis*. It is represented by the type and four other specimens from Panama, labeled as this species by Mr. Lawrence. In color these specimens present no very appreciable differences from the Chapada series. They measure as follows: wing, 3.40-3.78, averaging 3.59; tail, 3.34-3.54, averaging 3.44; exposed culmen, .72-.82, averaging, .76.

128. *Empidonax varius* (Vieill.).—This species is apparently a summer resident only at Chapada. The series of 15 specimens was taken as follows: September, 3; October, 3; November, 1; January, 2; February, 6.

Two young birds, taken Feb. 21 and 24, are still partly in first plumage, entirely lacking the yellow at the base of the crest feathers, while the cap is brown, with the feathers edged broadly with rufous, as are also the wing-quills and the lesser and primary coverts, the others being broadly edged with white. The dorsal plumage generally is also more or less edged with rufous.

129. *Tyrannus aurantio-atro-cristatus* d'Orb. & Lafr.—

The 7 specimens representing this species were taken one each in August, September and November, 2 in December, and 2 in February. It is to be inferred from this that it is only a summer visitor and not common.

One of the December specimens (taken Dec. 1) is a young bird in first plumage, with the quills not fully grown. Below it differs little in color from the adults, but above the upper tail-coverts, the quills, and the lesser and primary wing-coverts are broadly edged with dark rufous. The cap is dark brown externally, with the feathers basally rusty whitish, the central ones with a faint tinge of yellow.

130. *Tyrannus albogularis* Burm.—Evidently a summer visitor to Chapada. The series of 21 specimens covers the period from August 21 to February 24. The August and September specimens are in fresh plumage; in the January and February specimens the plumage is much worn and faded. The yellow of the lower parts varies from pale sulphur yellow to orange yellow, according to season.

The series shows a wide range of variation in the size and shape of the bill and in the depth of the forking of the tail, of which latter Dr. Sclater's figure (P. Z. S., 1880, p. 29) gives a rather exaggerated impression. The depth of the fork is generally under .75 in., varying in the present series from about .60 to .90. In other words it is only a little greater than in *T. melancholicus*, which, however, is a larger bird, thus increasing the relative difference.

Following are the measurements of 16 specimens, 8 males and 8 females: *Males*: wing, 4.13–4.37, averaging 4.27; tail, 3.60–4.02, averaging 3.82; exposed culmen, .70–.78, averaging .73. *Females*: wing, 3.96–4.22, averaging 4.08; tail, 3.46–3.82, aver-

aging 3.60; exposed culmen, .96-.74, averaging .72. General average, wing, 4.17; tail, 3.72; bill, .72.

131. *Tyrannus melancholicus* (Viell.).—Of the 22 specimens representing this species 15 were taken in September, 1885, and three others during the last week in August of the same year; two others were taken in September, 1882; the remaining two, one Feb. 28, 1883, and the other March 20, 1885. The species would thus seem to be an irregular visitor to the vicinity of Chapada, 18 of the 22 specimens having been taken during the month of September and the last week of August in 1885.

The March specimen is a young bird, just completing the molt from the first plumage. The yellow of the lower parts is much paler than in adults; the tail feathers are narrowly edged externally, and the two middle pairs also internally, with rufous; a few only of the colored crest feathers have appeared, and the tips of the primaries are not incised. The remnants of the first clothing plumage above are brownish gray. The rest of the series is quite uniform in coloration, although the yellow below varies somewhat in intensity in different individuals, and the olive brown above is much more greenish in some than in others.

The following measurements indicate the range of variation in size: 10 *Males*: wing, 4.28-4.72, averaging 4.50; tail, 3.98-4.50, averaging 3.83; exposed culmen, .84-.92, averaging .87. 6 *Females*: wing, 3.98-4.50, averaging 4.25; tail, 3.33-3.70, averaging 3.47; exposed culmen, .81-.90, averaging .86. The 18 specimens average as follows: wing, 4.38; tail, 3.65; culmen, .86. The forking of the tail varies from .45-.75, averaging about .60.

Besides the Chapada series, I have before me about a dozen other specimens from Southern Brazil and Bolivia. They agree very closely in size and coloration with the Chapada birds, but differ quite appreciably from other specimens from northern South America, Central America, Mexico, and southern Texas. While the whole form a rather closely connected series, the two extremes are exceedingly unlike. The northern form—*T. couchi* Baird (*T. melancholicus couchi* of recent American writers)—is easily distinguished from the true *T. melancholicus* of southern South America by (1) its much larger size (wing and tail each

.40 of an inch longer), (2) shorter and stouter bill, (3) much less deeply forked tail, (4) very much paler coloration both above and below (tail above grayish brown instead of black; the back olive gray instead of olive brown; throat and upper breast white instead of deep gray; less olive across the breast and the yellow of abdomen many shades deeper). Series of *T. m. couchi* and *T. melancholicus* when compared appear widely different, and specimens of either can be recognized at sight without the slightest difficulty. In fact, so far as the coloration of the ventral surface is concerned, *T. m. couchi* presents a very close resemblance to *T. albogularis*. For comparison in respect to size I append measurements of 7 specimens from the Lower Rio Grande Valley in Texas (Lomita Ranch, near Brownsville, Coll. George B. Sennett), as follows: 4 *Males*: wing, 4.70-4.98, averaging 4.89; tail, 3.68-4.15, averaging 3.91; exposed culmen, .80-.85, averaging .82. 3 *Females*: wing, 4.50-4.92, averaging 4.72; tail, 3.74-3.84, averaging 3.78; exposed culmen, .80-.86, averaging .83. General average of the 7 specimens (Chapada averages of 18 specimens in parenthesis for comparison); wing, 4.81 (4.38); tail, 3.87 (3.65); bill, .82 (.86). Depth of forking of the tail, .25-.35, averaging about .25 (.60).

A series of 8 specimens from Yucatan, Guatemala, and Panama (mostly unmarked for sex) are considerably smaller than the Texas series, averaging as follows: wing, 4.48; tail, 3.70; bill, .77. They are thus intermediate in size, as they are also in other characters, between *T. melancholicus* and *T. m. couchi*. Specimens from Cayenne, Trinidad, Venezuela, Colombia, and Amazonia are still smaller, and in coloration (except perhaps the Venezuela and Colombia specimens) more nearly approach *T. melancholicus*. They form, with the Central American birds, a thoroughly connected series, but being on the whole quite unlike either of the extremes, may very well stand as *T. m. satrapa*, under which latter designation the form was at one time recognized by various authors.

132. *Milvulus tyrannus* (Linn.).—Represented by 13 specimens, taken as follows: August, 5; September, 5; October 2; December, 1. Probably only a summer visitor.

(To be continued.)

Article XVIII. — CHARACTERS OF PROTOCERAS (MARSH), THE NEW ARTIODACTYL FROM THE LOWER MIOCENE.

BY HENRY FAIRFIELD OSBORN and J. L. WORTMAN.

Among the many interesting discoveries made by the American Museum Expedition of 1892 were the feet and portions of six skulls of a species of Artiodactyl which appeared to present entirely new characters. The finest specimen has proved to be a perfect skull with complete dentition; associated with another skull are the complete fore and hind feet. In writing from the field-camp Dr. Wortman described the skull as four-horned, but in the Museum, while the specimen was being worked out of its sandy matrix, we found six, eight and finally no less than ten bony protuberances upon different portions of the cranium! The chief pairs are on the parietals and maxillaries; prominent laterally projecting plates are also developed upon the supraorbital ridges of the frontals, and the frontals develop a second conical pair close to the nasal suture above the lachrymals. Besides the great vertical plates, the maxillaries present two lateral protuberances just above the third premolar on either side. The shape of these processes dismisses at once the idea that they were horn cores and indicates that they bore simply a dermal covering. Other features of the skull while less striking and novel are no less unique; among these are the deep cleft between the maxillary plates, the abbreviated nasals, the small vacuity between the nasals and frontals, the prominent ridge extending forward from the anterior margin of the orbit, and the prominent rugose sagittal crest. The grotesque appearance is heightened by the large canines which lend to the lateral aspect of the skull a decided suggestion of resemblance to that of *Uintatherium*.

The edentulous premaxillaries and short-crowned selenodont molars have the true ruminant appearance, but the structure of the feet at first sight suggests the Tragulines. We find two large and two small toes in the fore foot, all of them entirely

separate, while the hind foot is supported upon two elongated and closely conjoined digits which form an incipient cannon bone.



Fig 1. Lateral view of the male skull slightly oblique in position, $\frac{1}{3}$ natural size

Before looking for relatives of this remarkable animal, a second skull was uncovered, and it at first appeared to represent an entirely distinct species. The parietals were unfortunately lost in this specimen, but the frontals are complete and display no traces of either of the protuberances. Further examination, however, indicated the bases of the maxillary plates and of feebly developed canines, which suggested the idea that this skull might represent the female type while the former skull represented the male type of the same species. At this point Marsh's description of *Protoceras celer* was carefully studied and finally the supposed female skull was taken to the Yale College Museum, and upon being placed side by side with the type of *Protoceras* it was at once evident that they belong to the same species.

This enables us to fully characterize the male and female skulls of *Protoceras celer* Marsh, and to define the family *Protoceratidae*, which Marsh was unable to do from lack of sufficient material.

We may now (1) define the family, (2) give a new definition of the genus based upon the discovery of the sexual characters and differences between the male and female, and upon the characters of the feet, (3) define the species. (4) We will then expand Marsh's description of the female skull; (5) in comparison with the male skull; (6) the structure of the fore and hind feet together with the cranial characters throws some light upon (7) the affinities of *Protoceras*.

Order ARTIODACTYLA.

Family PROTOCERATIDÆ *Marsh.*¹

Molars brachy-selenodont. Upper and lower canines in both sexes. No upper incisors. Lower canines and incisors forming a single series. Male skull with bony protuberances upon parietals and frontals and vertical plates upon frontals and maxillaries. No true horns. Females with small parietal protuberances (maxillary plates unknown). Orbits posterior in position, prominent, widely separated. Optic foramina not confluent. Lachrymal duct with single orifice within rim of orbit. No lachrymal vacuity. Lachrymals articulating with nasals. Nasals extremely abbreviated. Maxillaries with large, free, superior border, produced (in the males) into a broad thickened plate rising above vertex of skull.

Fore feet with trapezium, trapezoid and magnum developed and distinct. Four complete, separate and functional metapodials, carpo-metacarpal articulation 'inadaptive.' Lunar resting equally upon unciform and magnum. Hind feet with two functional metapodials, lateral toes (II and V) incomplete. All elements of the pes separate in the young; tendency to form a cannon bone (III and IV) in adult stage. Ectocuneiform and navicular tending to combine (not with each other) with cuboid.

Fibula reduced to a malleolar bone tending to coösisify with tibia. Ulna well developed, tending to coösisify distally with radius.

This family is at present only known to include the genus *Protoceras* from the upper part of the White River Beds (Lower Miocene) of North America.

Genus *Protoceras Marsh.*²

Dentition: I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{1}{1}$, M $\frac{3}{3}$. First upper and lower premolars simple, bifanged, in diastema midway between canine and second premolar. Third and second upper premolars with strong internal cingula. Fourth upper premolar with single external and internal crescents. Lower incisors and canines with narrow spatulate crowns. Posterior nares open between second molars. Tympanic bulla not inflated. A strong lateral maxillary ridge.

Species *Protoceras celer Marsh.*³

Male: parietal protuberances large, laterally compressed, close together.

Female: parietal protuberances small, conic, widely separated.

Type: a female skull in the Yale College Museum.

¹ "A Horned Artiodactyle (*Protoceras celer*) from the Miocene," *American Journal of Science*, January, 1891, pp. 81, 82.

² Loc. cit.

³ Loc. cit.

THE SKULL.

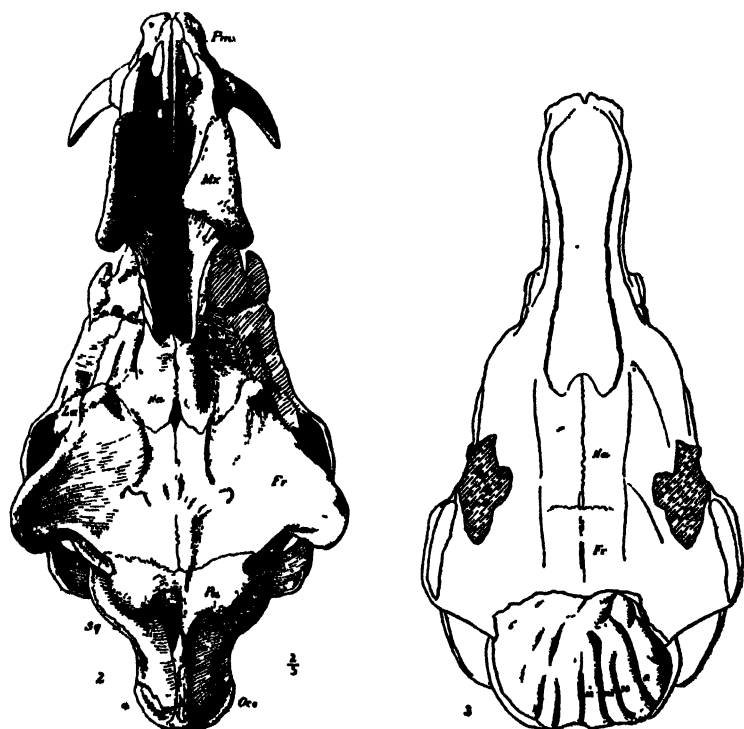
The Female Skull of Protoceras. History.—Marsh's type specimen is a skull with the posterior portion in fair preservation and the anterior portion broken off in a line just behind the anterior extremity of the nasals passing down just in front of the second premolar. In the following abstract of the author's description we omit some of the details, such as the absence of the first premolar, which are found to be incorrect :

"In general form and proportions this skull is of the ruminant type. Its most striking feature is a pair of small horn-cores situated, not on the frontals, but on the parietals immediately behind the frontal suture. . . . The horn-cores are well separated from each other, and point upward, outward and backward, overhanging somewhat the temporal fossæ. They are conical in form with obtuse summits. . . . The occiput is very narrow, indicating a small cerebellum, and the occipital crest is very weak. The occipital surface slopes backwards. . . . The facial region of the skull is narrow and elongate. On the outer surface of the maxillary just above the antorbital foramen, there is a deep depression which probably contained a gland. The usual ruminant fossa in front of the orbit appears to be wanting. The orbit is large, and completely closed behind by a strong bar of bone. . . . The paroccipital processes were well developed, but there were apparently no auditory bullæ. . . . As the animal represented by this skull is very distinct from any hitherto described, the genus may be named *Protoceras* in allusion to the early appearance of horns in this group. The species may be named *Protoceras celer*. The characters now known suggest affinities with the giraffes, but indicate a distinct family which may be called the *Protoceratida*."

Measurements of Type.—Distance between orbits across frontals, 75 mm., about 3 inches. Distance between summits of horn-cores, 32 mm., about $1\frac{1}{4}$ inches. Width of palate between true molars, 32 mm., about $1\frac{1}{4}$ inches. Length of skull, estimated at 200 mm., about 8 inches.

The female skull in the American Museum collection is in fair preservation; it has the cerebral hemispheres exposed, and entirely lacks the parietals and the occipital ring; the nasals are complete to the tip; the maxillaries have lost the superior border; the premaxillaries are complete. It is thus impossible to determine whether the maxillaries bore the large vertical plates which constitute so striking a feature of the male skull. Three features indicate that these plates were absent; first, the upper broken

border of the maxillaries is very thin; second, there are no protuberances or plates upon the frontals; third, the lateral ridge upon the maxillaries in front of the orbits is comparatively feeble and lacks the anterior projection. The wide contrast between the male and female skull is exhibited in the accompanying figures of the dorsal surface, and may be briefly summarized. The male skull is ornamented or armed with ten protuberances; the female skull bears but two small, low protuberances upon the parietals, not larger than the anterior pair upon the frontals of the male.



Figs. 2 and 3. Top views of the male and female skulls, $\frac{2}{3}$ natural size.

The *brain* is deeply convoluted. We observe upon each hemisphere four longitudinal gyri, these according to Owen's nomenclature would be the median (*m.*), medilateral (*m'*), supersylvian (*ss.*), and sylvian (*s.*). This skull measured when complete about

225 mm. Below are the principal measurements of the male skull, which belonged to a younger individual, and is slightly inferior in size, measuring 215 mm.

Measurements of Male Skull.

	mm.
From occipital condyles to tips of premaxillaries.....	215
Greatest width, outside supraorbital plates.....	111
Length of face, from anterior margin of orbit forwards.....	130
Length of cranium from anterior margin of orbit to occipital crest.....	100
Greatest depth of maxillary plates.....	115
Outside measurement, upper molars.....	57
Length pm ² -m ² inclusive.....	65

The Male Skull, Figs. 1, 2, 3.—The complete skull belongs to an animal about the size of a sheep, and is in an almost perfect state of preservation; all the sutures can be made out with certainty as outlined in the figures. The collection also contains portions of two other male skulls, one complete except in the posterior part and somewhat crushed; another, consisting of the complete posterior region and molar teeth; a third consisting of the anterior portion of the skull with the lower jaw as far back as the first premolar; with this individual the fore and hind feet were found associated. There are also two other fragmentary skulls not yet removed from the matrix.

Aside from the protuberances, the skull is long and low. Compared with the cervine type it is remarkable in the relative non-expansion of the olfactory chamber; there is in fact no space for great extension of the turbinals. Upon the upper junction of the frontals and nasals is an apparent foramen (this is less open in the more mature female skull).

A second distinctive feature is the exceptional development, correlated with the protuberances, of prominent ridges of bone which form a strong outer framework, thus the temporal fossa is bounded by rugose lambdoidal and sagittal crests, and by a strong buttress extending from the parietal horns to the postorbital bar, and supraorbital plate. In front of the orbits the lachrymals are depressed between two ridges, the upper ridge extending into the frontal protuberance, the lower ridge consisting first of the malar (*ma.*) and then passing into the maxillaries, and terminating in a

stout incurved hook above the infraorbital foramen. From this hook extends forward and upward a stout flange to brace the high maxillary plates. Immediately above this hook is the pit mentioned by Marsh; it probably did not contain a gland. Again, the vertical maxillary plates have a strong inward convexity, but are not quite in contact.

The protuberances are of two kinds; there are, *first*, the sub-conical projections, such as the elevated parietal processes crowning the superciliary ridges, which diverge, <-like, from the sagittal crest to the orbits; these parietal processes are flattened oval, and obliquely placed. Of somewhat the same character are the small semiprocumbent processes at the anterior margins of the frontals just above the lachrymals. The smallest of these processes are the hooks upon the lateral maxillary ridges, which none the less illustrate the extraordinary tendency of this little skull to rival the Dinocerata in developing a protuberance at every available point.

There are, *second*, the bony plates, which are flattened, with rugose margins. The supraorbital plates are developed upon the frontals and completely overhang the orbits, as shown in Fig. 2. Somewhat similar plates are seen in other Ungulates. The whole conformation of the maxillaries is, so far as we know, unique among the mammalia; the superior borders curve sharply upward into two powerful plates of bone, concave on the outer side and

convex on the inner, and rising to the level of the parietal processes, with a concave posterior and convex anterior border.

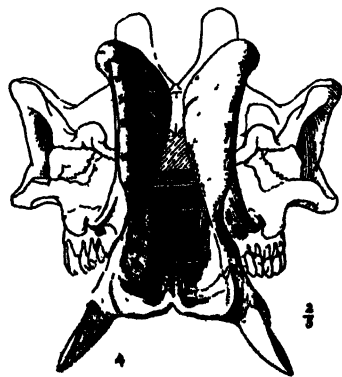


Fig. 4. Anterior view of the male skull,
3/4 nat. size.

Cranial and Facial Bones.—The limits of the various elements of the skull can be clearly made out. The occiput is narrow and overhanging, the occipitals extend into the temporal fossæ; the paroccipitals are overlapped by the rugose periotics, beneath which the slender paroccipital processes emerge. The external

auditory meatus is narrow and incompletely surrounded by the small tympanic elements. The squamosals have a small ascending plate; as observed by Marsh, the postglenoid processes are small; the zygoma is rather slender. The malars are large, forming a horizontal infraorbital plate and extending forwards upon the face. The lachrymals are depressed but extend into a narrow surface of contact with the nasals; the foramina are internal. The parietals embrace the bases of the two posterior protuberances. The frontals bear the supraorbital plates and median protuberances; their upper surface has a strong median convexity bounded laterally by grooves for the supraorbital arteries and frontal nerves. This convexity continues into the nasals and terminates at their tips; in the female it forms the vertex of the skull, but in the male it lies in the centre of a hollow basin. The nasals are somewhat overlapped anteriorly by the maxillaries. The base of the skull displays a long narrow palate, narrowing opposite the diastema and broadening out into the smooth, perforated premaxillaries. The posterior nares open between the second molars.

The Foramina.—The infraorbital foramen is placed directly above the third premolar. The lachrymal foramen is within the orbit. There is a postglenoid foramen. The foramina lac-medius and lac-posterius are small. The foramen ovale is distinct.

The Dentition.—In the male the superior canines are trihedral and project outwards and backwards; the outer and inner faces are very slightly convex; the posterior face is flat and slightly worn. At a short interval are the first premolars, simple, laterally compressed crowns supported upon two fangs. The second premolars are behind a slightly greater interval. The outer surface is divided into a central cusp and two basal cusps, flanked by anterior and posterior styles; there is a sharply defined internal cingulum. The second premolar repeats the same characters, being more sharply defined. The fourth premolar has a shorter external crest, and the internal crescent is strongly developed, replacing the internal cingulum of the second and third premolars.

The true molars present a strong internal basal cingulum which envelops the inner surface of the crown; the outer surface of the crown is marked by prominent basal cusps, viz.: the parastyle, mesostyle and metastyle; the main external cusps are sub-crescentic, and present a strong median external ridge, their outer surface therefore is convex rather than flattened; the internal cusps, protocone and hypocone, are sharply crescentic. The molar dentition is therefore of an early type and decidedly brachyodont.

The inferior incisors present delicate spatulate crowns; the median second incisors are slightly larger than the lateral incisor, which is very delicate. The canine has precisely the same delicate structure as the lateral incisor. In the female the canines are apparently very much smaller, not exceeding half the diameter exhibited in the male.

In the fragment of the lower jaw the first lower premolar is seen to be separated widely from the canine.

THE FORE AND HIND FEET.

The materials upon which this description is based consists of an almost complete manus, including the distal ends of ulna and radius, together with both hind feet, to which the distal ends of the tibia and fibula are attached. Associated with these feet was found the anterior portion of the cranium bearing the lower jaw, so that their reference to *Protoceras* is undoubted. These are all that remained of what was once a complete skeleton deposited in position, but which had been almost completely destroyed by weathering away of the matrix. They pertain to a comparatively young animal in which the epiphyses had not yet fully united.

A second specimen is represented in the collection, consisting of the greater portions of both hind feet. This also pertains to a moderately young animal, but the epiphysis appear to be well joined to the rest of the bone and it can perhaps with safety be said to be fully adult.

In a general survey of the proportions of the limbs the same striking disparity in length and size is to be observed as is found in the *Tragulidæ*. The pes is much longer and stronger than the manus and, as in the *Tragulines*, had become much more

highly specialized in the matter of reduction of the lateral digits. The pelvis, scapula and long bones are unknown.

The Fore-arm.—The ulna and radius, as indicated by their distal ends, display nearly the same proportions as are to be found in the existing Tragulines. The ulna is perhaps a trifle larger and stronger in proportion to the radius, with a greater expansion of its distal end. It is much better developed than in any of the existing Cervidæ. These two bones, although pertaining to a young animal in which the epiphyses are clearly indicated, are closely applied to one another, and display what may be regarded as a tendency to coössification. In old individuals it is highly probable that they will be found to be more or less completely joined by bony union.

The shaft of the radius, or what remains of its distal portion, is slightly crushed laterally so that its section cannot be made out, but there can be little doubt that it had the usual pattern displayed by the Tragulines and modern Deer. Upon the front of the bone, just above the articular extremity, there is a wide tendinal sulcus somewhat more marked than in either *Tragulus*, *Leptomeryx* or *Cariacus*. (In these latter genera there is an additional tendinal groove situated well over towards the ulnar side of the bone, which is apparently absent in *Protoceras*. Its absence in this specimen, however, may be due to age.) The distal extremity of the bone is marked by two facets for articulation with the scaphoid and lunar. That for the scaphoid is strongly convex from before backwards and is terminated in front by a shallow pit or depression which receives the anterior convex head of the scaphoid.

The process of bone which bears this facet is not produced backwards as it is in *Tragulus*, nor has it the marked obliquity seen in *Leptomeryx* and *Cariacus*, and to a less degree in *Tragulus*. The scaphoid facet is not sharply defined by a prominent ridge from that of the lunar as it is in *Cariacus*, *Leptomeryx* and *Tragulus*, the two articular surfaces being quite continuous in front.

The lunar facet is somewhat wider than that for the scaphoid, and like the latter is strongly convex from before backwards. It has little or no obliquity. It differs markedly from that of *Lep-*

tomeryx, in which it consists of a shallow cup-like depression with little posterior convexity associated with great obliquity. In *Protoceras*, as in *Tragulus*, the scaphoid surface occupies a lower level than that for the lunar, while in *Leptomeryx* the two facets are almost upon the same level.

In the complete absence of any articular facet for the cuneiform, the distal end of the radius differs from all modern Pecora and from the existing Tragulines, and agrees with *Leptomeryx*, an older Traguline.

The ulna is much compressed and applied closely to the radius at its lower fourth. Its distal extremity is occupied by an antero-posteriorly convex facet which articulates with the cuneiform. Except in its slightly increased size, in proportion to the radius, it does not differ from the corresponding bone in *Tragulus*.

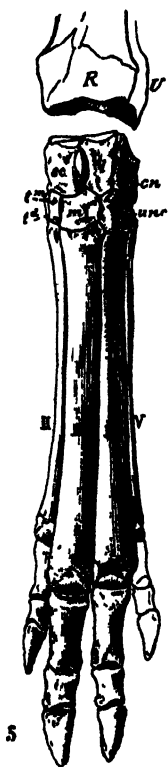


Fig. 5. Front view of manus, $\frac{1}{2}$ nat. size.

The Carpus.—The carpus, while it resembles that of the Tragulines in a general way, nevertheless presents many features in details of structure which are different enough. One character in particular in which it appears to differ from both the Tragulines and the modern Cervidæ is the degree of elevation observable in the distal row of carpal bones. In *Cariacus* the vertical flattening of these bones is very marked, and it is also to be observed in the Tragulines, including *Leptomeryx*, although to a less degree. In *Protoceras* the elevation is considerably greater, so that the height of the two rows of bones is more nearly equal. In this respect it approaches *Oreodon* and the more generalized members of the Artiodactyla.

The scaphoid is one of the largest and strongest bones of the carpus. Proximally it presents a saddle-shaped articular facet where it joins the radius, in conformity with the usual pattern in the Artiodactyla. The anterior portion of this articular surface is occupied by a well-rounded transverse ridge extending entirely

across the superior face and giving a width almost equal to that of the lunar. This ridge is received into the transverse depression upon the distal end of the radius. In *Tragulus* the proximal articular surface of this bone is much narrower than that of the lunar, and the anterior portion is thrown up into a prominent bony tubercle which is received into a corresponding pit or depression upon the articular face of the radius. Although the scaphoid is unknown in *Leptomeryx*, one would conclude from the depression in the radius at its point of articulation, that its structure is similar to that of *Tragulus*. In *Cariacus* the bone is similar to that of *Tragulus*, although the lateral narrowing is not relatively so great. Distally the scaphoid of *Protoceras* rests upon the magnum and trapezoid, being at the same time in contact with the rudimental trapezium.

The lunar is relatively high and narrow, being slightly wedge-shaped. Proximally it presents the usual pattern of the Pecora and Tragulines, but distally its articular surface is divided almost equally between the unciform and magnum. In this respect it differs radically from *Leptomeryx* and all other Tragulines, in which it rests almost entirely upon the unciform, offering to the magnum only a lateral contact. This character is considered by Cope¹ and adopted by Scott² as especially characteristic of the Traguline group.

The cuneiform is proportionally stronger than in the *Cervidæ*, and the saddle-shaped proximal facet is not extended down upon the external surface to the same extent as in either the Tragulines or the modern Pecora. It does not articulate with the radius.

The unciform is the largest bone of the carpus and articulates proximally with the lunar and cuneiform. Posteriorly it develops a strong hook-like process of bone, which is absent or nearly so in *Cariacus* but present in *Tragulus*. Distally it articulates with with metacarpals III, IV and V.

The magnum of *Protoceras* differs from that of both the Tragulines and the Pecora in that it is entirely free, and exhibits no tendency to coössification with the trapezoid. It articulates

¹ On the Structure of the Feet of the Extinct Artiodactyla of North America. Proc. Amer. Assoc. for Advancement of Science, 1884.

² On the Osteology of Mesohippus and Leptomeryx. Jour. Morphology, 1891, Vol. V, No. 3.

proximally with scaphoid and lunar, distally with metacarpals II and III.

The trapezoid is comparatively large and well developed. It assists in the support of the scaphoid and in turn rests solely upon metacarpal II. Internal to this bone is a small bone which represents the reduced trapezium. It has a small articular facet where it touches the scaphoid, but distally there is apparently no facet for the support of metacarpal I. If this first digit or any representative of it were present it was reduced to the merest rudiment. In the presence of this small trapezium the carpus of *Protoceras* is of a more generalized type, differing from both the Tragulines and the Pecora. This bone is, however, occasionally seen in the modern Cervidæ.¹

The Metacarpus.—The metacarpus consists of four digits, all of which are distinct and show no tendency to unite. As regards the existence of the first digit, as remarked above, if present, it consisted of a rudiment. The lateral digits II and V are remarkable for their unusual size as compared with the median ones III and IV. They are relatively as large as those of *Oreodon*, although much more elongated and slender, to conform to the general pattern of the foot. They are but little inferior to the median digits in length, in this respect resembling *Leptomeryx*. Metacarpal II is slightly larger and slightly exceeds metacarpal V in length. Its principal articulation is with the trapezoid, but it offers a small oblique facet to the magnum, and is overlapped behind by the rudimental trapezium.

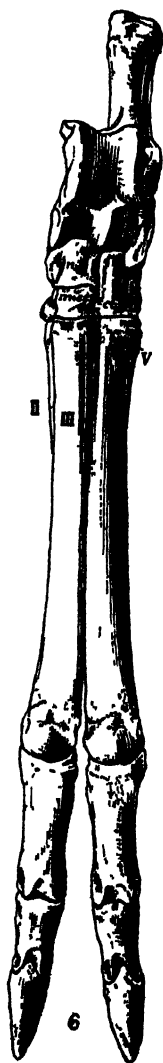
As metacarpal II articulates with two principal elements of the carpus, so does metacarpal III. The head of the bone is largely occupied by an articular facet for the magnum, but on its ulnar side it sends out a considerable process which joins the unciform and at the same time overlaps the head of metacarpal IV. Metacarpals IV and V articulate proximally with the unciform only.

The distal ends of all the metacarpals are provided with keels, which are confined to the palmar surfaces. These keels are flanked upon either side by a well-developed sesamoid, well preserved in the specimen described.

¹ See Baur: 'Der Carpus der Paarhufer,' *Morphol. Jahrb.*, IX, 506, 606.

Summary.—A summary of the principal characters of the forelimb, or, at least, what we know of it, may be made as follows :

- (1) Distal ends of ulna and radius tend to coössify.
- (2) There is no radial facet for the cuneiform.
- (3) There is little or no obliquity of the scaphoid and lunar facets on the radius.
- (4) The lunar rests equally upon unciform and magnum.
- (5) Trapezoid and magnum are not coössified.
- (6) A trapezium is present though small.
- (7) The unciform has a well-developed hook posteriorly.
- (8) The lateral digits are large, almost equaling the median ones in size.
- (9) Metacarpal III does not articulate with trapezoid, and the manus is therefore of the 'inadaptive' type.
- (10) The distal keels of the metacarpals are confined to the palmar surface.



The Hind Limb.—All that remains of the tibia and fibula are the extreme distal ends. Of the tibia we note the deep grooves for articulation with the astragalus, very much as in the recent genus *Cariacus*. The fibula is as completely reduced as in the modern Deer, the distal end consisting of a nodule of bone wedged in between the tibia and calcaneum. While this nodule, or malleolar bone, is free in the single specimen in which it is preserved, it nevertheless exhibits some tendency to coössify with the tibia, and it would not be at all surprising to find it completely joined to the tibia in older specimens.

Of the tarsus, the calcaneum has a relatively shorter *tuber* than is found in the modern Deer, and the facet for the malleolar bone is much more flattened. The astragalus presents no points of especial interest ; it resembles very closely the corresponding bone in *Cariacus*.

Fig. 6. Front view of pes, $\frac{1}{2}$ nat. size.

The cuboid is relatively high and narrow, in this respect, resembling the Tragulines rather than the Deer.

Although closely applied to the navicular and the ecto-cuneiform it is not coössified with them as is the case in the Tragulines and Pecora. In a young specimen of *Leptomeryx* in our collection the cuboid and navicular are fully united and all traces of the suture are obliterated, notwithstanding the fact that the epiphyses had not yet united with the shafts of the long bones. Now in our young specimen of *Protoceras* the cuboid and navicular are perfectly free, but in the adult specimen there is some bony union. The line of junction, however, is clearly indicated by a more or less open suture. What is here said of the cuboid and navicular also applies to the cuboid and ecto-cuneiform, so far at least as the union of the latter with the cuboid is concerned. There appears to be no tendency to bony union of the ecto-cuneiform with the navicular.

The comparatively large bone which furnishes the principal support for the navicular, is, upon good and sufficient authority, stated to be a compound of the ecto- and meso-cuneiform in all the Pecora and some of the Tragulina. A very similar bone is found in *Protoceras*, but there is apparently no trace of any suture separating the two elements. It is safe to assume therefore that this bone represents the coössified ecto- and meso-cuneiform. Almost immediately behind this is to be found the ento-cuneiform. It differs in no important particulars from that of the Tragulines, *Leptomeryx*, and the Pecora.

The metatarsus consists of four elements of which the two median bones, metatarsals III and IV, are well developed and functional. The two median ones, viz. : Metatarsals II and V, are rudimental, incomplete and splint-like. In the young specimen metatarsal II greatly exceeds metatarsal V in size, extending somewhere between a third and a half of the way down the shaft of the large metatarsal III, while metatarsal V is but a short splint. In the adult specimen metatarsal II is very much shorter and is reduced quite as much as metatarsal V is in the young specimen. This is perhaps to be explained upon the basis of individual variation.

Metatarsal II articulates proximally with both the ento- and the meso-cuneiform, being applied closely to the shaft of metatarsal III. Its distal portion is not preserved, if it were ever

present, so that no statement can be made concerning it. This is likewise true of metatarsal V.

Metatarsals III and IV are large and strong. In the young specimen they are entirely free, but in the adult there is some tendency to bony union exhibited, just as is observed in the cuboid, navicular and ecto-cuneiform of the tarsus. The fact of the matter is, the pes of *Protoceras* furnishes us with the transition stage between the condition wherein the elements are free, upon the one hand, and that wherein they become fused on the other. It is highly probable, as our specimens tend to prove, that previous to, and up to the time that the animal was fully adult, the elements of the pes were entirely free, but as age advanced there was a tendency for certain of the bones to become coössified. We are of the opinion, however, that bony union had, at no time during the life of the individual, gone so far as to obliterate all traces of the connections between the originally separate elements. In this sense no cannon bone can be said to exist in *Protoceras*. The bony union at most was but incipient.

In metatarsals III and IV the distal keels are confined to the plantar surface and are therefore not complete as in the modern Ruminants. The phalanges do not offer any important points of difference from those of allied forms.

SYSTEMATIC POSITION OF *PROTOCERAS*.

It now remains to discuss briefly the systematic position of this unique genus. Scott, following Rutimeyer,¹ gives the principal characters of the traguline skull, including the American Miocene genus *Leptomeryx*, which, as he has shown, probably belongs here, as follows: "(1) Size very small. (2) Craniofacial axis straight. (3) The orbits very large, median in position, and separated by a thin septum, but not projecting much beyond the sides of skull; optic foramina confluent. (4) The cranium long, narrow and low, and the parietal zone correspondingly long. (5) Occipital surface unusually high, narrow and convex (flattened or concave in *Leptomeryx*), and supraoccipital extended upon the side walls of cranium. (6) The alæ orbitales

¹ On the Osteology of *Meshippus* and *Leptomeryx*, pp. 358, 359.

extraordinarily extended, reaching roof of the skull. (7) A short sagittal crest formed. (8) Frontal zone limited to roof of the orbits and nasal cavity. (9) Auditory bullæ large and filled with cancellous tissue (small and not filled with cancellous tissue in *Leptomeryx*). To these we may add: (10) no horns or bony protuberances upon the cranium, and (11) "the lachrymal orifice single and placed outside the orbit (McAllister)," "inside the orbit in *Leptomeryx* (Scott)."

If now we contrast the characters of the skull of *Protoceras* with those of the *Tragulina* just given, it will be seen that the differences are very great. (1) Omitting Scott's first character as of comparatively little value, since it is a matter of specific variation in other forms, they may be tabulated as follows: (2) In *Protoceras* the face is considerably bent down upon the craniofacial axis as in the *Pecora*. (3) The orbits are large, lateral in position, widely separated and project well beyond the side wall of the skull. The optic foramina are not confluent. (4) The cranium is long, flattened and of great breadth between the orbits; the parietal zone is relatively short. (5) The occipital surface is high and narrow and the occipitals overlap the lambdoidal crests so as to appear upon the side walls of the skull. (6) This character cannot be fully determined in our specimen. (7) A very prominent, although moderately short crest is formed in the male, less prominent in the female. (8) Frontal zone limited behind by parietal protuberances. (9) The auditory bullæ not inflated. (10) Strong bony protuberances on parietals, in males well developed, in females rudimental; in males there are in addition bony protuberances over the orbit and in front of the orbit on the frontals, besides the large maxillary plates in front. (11) The orifice of the lachrymal duct is single and situated inside the orbit.

From this it will be seen that in the general pattern of the skull *Protoceras* differs widely from that displayed by any member of the *Tragulina*. The more striking and important of these differences are to be seen in the position and wide separation of the orbits, the possession of parietal protuberances and the general conformation of the muzzle. It is true that in the character of the occiput it resembles the *Tragulines*, but it is not certain but

that some of the more primitive members of the Pecora were possessed of a similar structure. In the matter of the tympanic bullæ and the position of the lachrymal orifice it agrees with *Leptomeryx*, but differs from the rest of the Tragulines. These latter characters are probably but parallelisms and have little bearing upon the general question of genetic affinity.

In the structure of the limbs we meet with more decided resemblances to the Tragulines, but in the absence of more complete knowledge of the limb structure of the earliest representatives of the Pecora we are not prepared to say whether these resemblances are not equally great to this latter group. The manus furnishes two striking characters in which *Protoceras* differs from all the Tragulina, viz.: the support for the lunar being furnished by the unciform and magnum equally and the manus being of the 'inadaptive type,' whereas in the Tragulina the principal support for the lunar is furnished by the unciform, and the manus is of the 'adaptive type.' The character of the lunar articulation is considered by Cope to be especially distinctive of the Tragulines, and it is undoubtedly true that it is very constant and serves to distinguish them sharply from the Pecora. The adaptive or inadaptive character of the manus is perhaps of less value in indicating relationship, since it appears, in some measure at least, to be influenced by the 'reduction of the digits. Such a condition is met with in the Oreodontidæ.

Other characters of the carpus, such as the separate condition of magnum and trapezoid, the presence of separate trapezium, and the very large size of the lateral metacarpals are features common to the more generalized types of the Artiodactyla, and serve to distinguish *Protoceras* sharply from both the Pecora and the Tragulina. The lack of obliquity of the facets at the distal end of the radius is also a character which belongs to the primitive members of the order and serves to distinguish it from both the Tragulines and the Pecora, while the absence of a cuneiform facet on the radius, as well as the presence of the distal keels of the metapodials on the palmar surface only are shared with certain members of the Tragulina, notably *Leptomeryx*.

If we associate *Leptomeryx* with the Tragulines, then the differences in the structure between the pes of the Pecora and the

Tragulina is comparatively slight. The pes of *Leptomeryx*, as was shown by Scott, is remarkably like that of the modern Ruminants in the reduction of the lateral digits and the coössification of the cuboid and navicular, and at the same time in having ecto-meso-cuneiform free. In *Protoceras* the condition is more primitive, in that the cuboid and navicular are not fully united, nor can the cannon bone be said to be fully formed. In these particulars it departs from both the Tragulina and Pecora and again approached the lower types.

If now we compare *Protoceras* with any family of the Pecora, there are so many striking differences at once apparent that we are compelled to conclude that there are no marked affinities in the direction of any of these families. In the possession of bony protuberances on the parietals, which are probably processes of this bone and not developed separately as in the Giraffe, in the general architecture of the skull, together with so many primitive characters of the feet, this genus apparently occupies a distinct position and cannot be consistently referred to either the Tragulina or the Pecora as at present constituted and defined. The possession of multiple horns suggests the possible relationship of this family to the Sivatheriidæ, but the likeness does not extend to other features of the skull.

That it represents a distinct family there can be little doubt. Of its successors we know nothing whatever, and our ignorance is equally great in the matter of its ancestry.

The following table exhibits, in condensed form, the principal characters of this family in contrast with those of the families of the Tragulina and the Pecora :

TRAGULINA. <i>Tragulidae.</i>	PROTOCERATIDÆ.	PECORA. <i>Giraffidae, Cervidae, Bovidae.</i>
(1) No horns, antlers or bony protuberances upon cranium.	(1) Paired bony protuberances on parietals, frontals and maxillaries in males.	(1) Horns, antlers or bony protuberances present.
(2) Orbits median in position, not projecting laterally; optic foramina confluent.	(2) Orbits lateral in position, projection well beyond side wall of skull; optic foramina not confluent.	(2) Orbits as in Protoceratidae.
(3) Nasals normal and articulating with superior border of maxillaries in front. No flanges on maxillaries.	(3) Nasals much reduced and not articulating with superior border of maxillaries in front. Maxillaries in males produced into a pair of large bony plates rising above the vertex of the skull.	(3) Nasals normal (somewhat reduced in <i>Alces</i>) and articulating with superior border of maxillaries in front. No maxillary plates.
(4) Occiput high and narrow; occipitals overlapping lambdoidal crest; a sagittal crest formed.	(4) Occiput high and narrow; occipitals overlapping lambdoidal crest; a sagittal crest.	(4) Occiput low and broad; occipitals not overlapping lambdoidal crest. No sagittal crest.
(5) Distal end of radius with or without facet for articulation with cuneiform. Facets for scaphoid and lunar oblique.	(5) Distal end of radius without facet for articulation with cuneiform. Facets for scaphoid and lunar with little or no obliquity.	(5) Distal end of radius with facet for articulation with cuneiform. Facets for scaphoid and lunar very oblique.
(6) Carpus of the adaptive pattern.	(6) Carpus of the inadaptive pattern.	(6) Carpus of the adaptive pattern.
(7) Lunar resting almost exclusively upon the unciform, and having only a lateral contact with magnum.	(7) Lunar resting equally on magnum and unciform.	(7) Lunar resting equally upon magnum and unciform.

(8) Trapezoid and magnum coössified.	(8) Trapezoid and magnum separate.	(8) Trapezoid and magnum coössified.
(9) Trapezium absent or coössified with trapezo-magnum.	(9) Trapezium present and separate.	(9) Trapezium absent, rudimentary; or coössified with trapezo-magnum.
(10) Lateral digits of manus complete; cannon bone present or absent.	(10) Lateral digits of manus complete, large and well-developed; no cannon bone.	(10) Lateral digits incomplete and splint-like; a cannon bone always present.
(11) Distal keels of metacarpals incomplete and confined to palmar surface.	(11) Distal keels of metacarpals incomplete and confined to palmar surface.	(11) Distal keels of metacarpals complete (except in Giraffe).
(12) Cuboid, navicular and cuneiforms coössified (excepting in <i>Lophomeryx</i> , where ecto-meso-cuneiform is free) with obliteration of suture in adult.	(12) Cuboid tending to coössify separately with navicular and cuneiforms, persistent suture in adult	(12) Cuboid and navicular coössified, with obliteration of suture in adult.
(13) Lateral digits of pes complete (except in <i>Lophomeryx</i>); cannon bone present or absent.	(13) Lateral digits incomplete, splint-like; median metatarsals, if coössified into a cannon bone, a persistent suture present.	(13) Lateral digits incomplete, splint-like; and median metatarsals always coössified into a cannon bone, with suture obliterated in adult.
(14) Distal keels of metapodials confined to plantar surface.	(14) Distal keels of metapodials confined to plantar surface.	(14) Distal keels of metapodials complete (except in Giraffe).
(15) Posterior limbs greatly exceeding anterior limbs in size and length.	(15) Posterior limbs greatly exceeding anterior limbs in size and length.	(15) No marked disparity in length between fore and hind limbs.

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